Flight Instructor Guide

CIVIL AVIATION AUTHORITY OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

Te Kāwanatanga o Aotearoa
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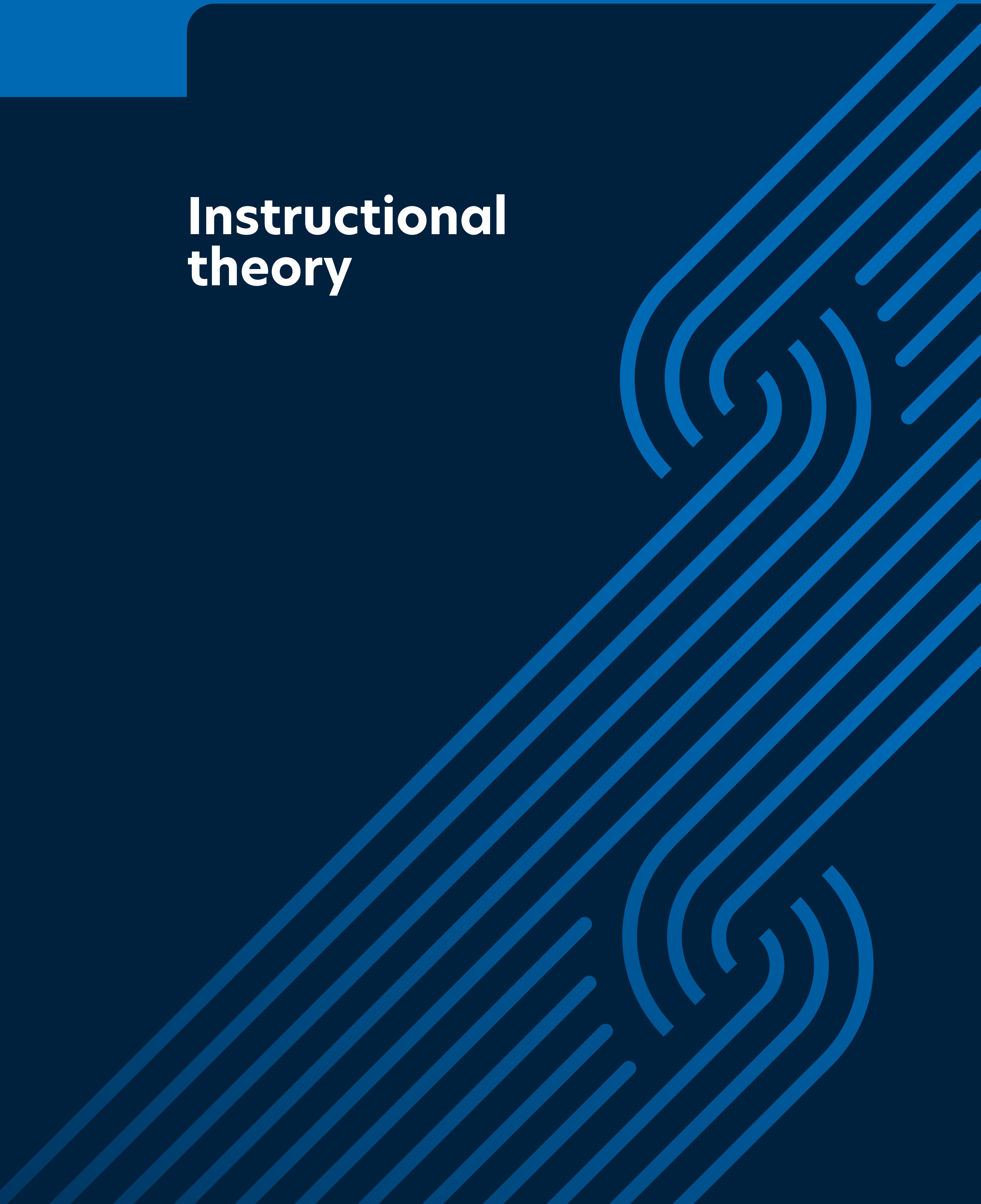


Instructional theory introduction

This section of the Flight Instructor Guide supports the Instructional Techniques Course required for an instructor rating.

The expert flight instructor is master of many skills and fields of knowledge. What is taught demands technical competence in these areas, but how the teaching is accomplished depends on your understanding of how people learn and the ability to apply that understanding. The following gives some insights into the learning process and is meant to guide you into areas of further study. Teaching is a rewarding experience, but those rewards are not easily achieved. It is doubtful that anyone has a natural ability to teach or understand how others learn, therefore the professional instructor continues the life-long process of learning not only flying skills but also teaching skills.

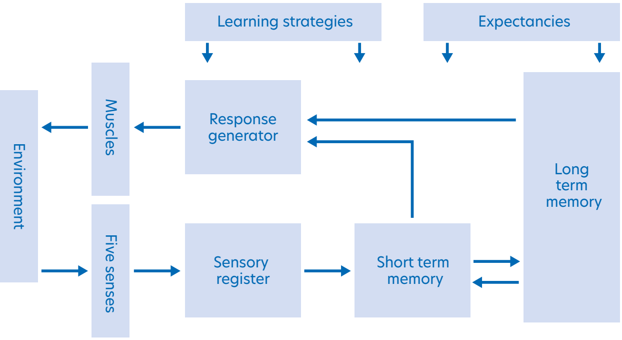
It is intended that this section be reviewed regularly so that you gain the most benefit from it. As your experience widens, you will need to draw on a wider and wider variety of teaching methods so that you can maximise your student's learning. Refreshing this section should help you remember those teaching methods that you may not use very often.

Information processing

To understand how a person learns, we first need to consider a basic model of information processing[1] (see diagram below).

Figure 1

Information processing



The five senses are acted on by the environment (the cockpit, classroom or instructor) and the information is passed by the nervous system to the sensory register. The information remains in its original form for only a fraction of a second while pattern recognition takes place, giving form and shape to the information.

The information passed to the short-term or working memory, is coded as a concept. For example, the word aeroplane takes on meaning, but information received from long-term memory may modify that concept, say to a jet aeroplane. This re-coded information is passed to long-term memory for storage or is acted on.

Information from either short-term or long-term memory is passed to the response generator, or decision-maker, and this information is passed through the nervous system to the body's muscles, which act on the environment.

This whole process is affected by expectancies. For example, you will probably have had an experience of seeing what you wanted to see, rather than what was actually there. Expectancies affect the way information is perceived, the way it is coded, and the generated response.

The process is further affected by the strategies used to encode the information – learning strategies. For example, the use of mnemonics or mind-mapping to store information can greatly affect later retrieval.

Definition of learning

To define learning, it is necessary to analyse what happens to the individual. As a result of a learning experience, an individual's way of perceiving, thinking, feeling and doing may change. Therefore, learning can be defined as "a change in behaviour as a result of experience that persists"[1]. The behaviour can be physical and overt, or it can be intellectual or attitudinal, and therefore not easily seen. Learning occurs continuously throughout a person's lifetime.

Characteristics of learning

Learning comes from experience

The student can only learn from individual experience. A person's knowledge is a result of experience, and no two people have had identical experiences. Even when observing the same event, two people react differently; they learn different things from it, according to the manner in which the situation affects their individual needs. Previous experience conditions a person to respond to some things and ignore others.

All learning is by experience[3], but it takes place in different forms and in varying degrees. Some experiences involve the whole person, while others only the ears and memory. You are faced with the problem of providing experiences that are meaningful, varied and appropriate; for example, by repeated drill, students can learn to say a list of words, or by rote they can learn to recite certain principles of flight. However, they can only make them meaningful if they understand them well enough to apply them correctly to real situations. If an experience challenges the learner, requires involvement with feelings, thoughts, memory of past experiences, and physical activity, it is more effective than an experience in which all the learner has to do is commit something to memory[2].

It seems clear enough that the learning of a physical piloting skill requires experience in performing that skill. However, mental habits are also learned through practice. If students are to use sound judgement and solve problems well, they must have had learning experiences in which they have exercised judgement and applied their knowledge of general principles in the solving of realistic problems.[4]

Learning must have relevance

Each student sees a learning situation from a different viewpoint. Each student's past experience affects readiness to learn. Most people have fairly definite ideas about what they want to achieve. Therefore, each student has specific goals and their needs and attitudes may determine what they learn as much as what you are trying to get them to learn. Students learn from any activity that tends to further their goals. The effective instructor must discover the student's goals and seek ways to relate new learning to those goals[1].

Learning outcomes are multiple

If instructors see their objective as being only to train their student's memory and muscles, they underestimate the potential of the teaching situation. Students may learn much that you did not intend, for they did not leave their thinking minds or feelings at home, just because these were not included in your lesson plan. Learning can be classified by type as: verbal, conceptual, perceptual, motor, problem solving and emotional. These divisions are artificial, however. For example, a class learning problem solving may learn by trying to solve real problems. In doing so it is also engaged in verbal learning and sensory perception. Each student approaches the task with preconceived ideas and feelings, and for many students these ideas change as a result of the experience. The learning process, therefore, may include many types of learning, all taking place at the same time.

In another sense, while learning the subject at hand, students may be learning other things as well. They may be developing attitudes about aviation, good or bad, depending on what they experience. You must always display a professional attitude, regardless of whether or not instruction is actually taking place. This learning is sometimes called incidental[5], but it may have a great impact on the total development of the student.

Learning is an active process

You cannot assume that students remember something just because they were present in the classroom, briefing or aircraft when you taught it. Neither can you assume that the students can apply what they know because they can quote the correct answer from the book. For the students to learn, they must attend to instruction, react and respond by relating information to their knowledge and experience, construct meaning from that interaction, and attribute results to their own effort[2]. If learning is a process of changing behaviour, that process must be inter-active and observable.

Learning theory

Learning components

Psychologists over the years have proposed various theories on learning, and from these we can gain an insight into the learning process. Listed below are some of the most widely accepted learning components, sometimes referred to as 'Laws of learning'.

Primacy

What is taught first, often creates a strong, almost unshakeable impression. Therefore what is taught, and what is learnt, must be right the first time. Un-teaching is more difficult than teaching.

Readiness

The student learns best when they are ready to learn, motivated, and understand clearly the objectives for the lesson. Being ready to learn also entails consideration of Maslow's hierarchy of human needs (see **Human behaviour**). A student distracted by fatigue, stress, home or relationship issues, etc, will not be ready to learn.

Relevance / Belonging

Individuals learn best when they see a reason for learning. If students have a clear objective, and a well defined reason for learning, they make rapid progress. You must explain the relevance of each lesson. For example, why must the student recognise the symptoms of the approaching stall? Where does this lesson fit with those covered previously, and those lessons ahead?

Repetition

Those things most often repeated are best remembered[6]. Every time practice occurs, learning continues. Students do not learn crosswind landings from one instructional flight. You must provide opportunities for practice and must see that this process is directed toward a goal.

Rewards, reinforcement, or conditioning

"One of the most powerful forms of reward available to the instructor is praise"[7]. Learning is strengthened when accompanied by a pleasant or satisfying feeling and weakened when associated with an unpleasant one. Termed the 'Law of effect', it is based on the emotional reaction of the learner. An experience that produces feelings of defeat, frustration, anger, confusion or futility is unpleasant for the student. If, for example, an instructor attempts to teach landings during the first flight, the student is likely to feel overwhelmed. Impressing the student with a difficult manoeuvre can make the later teaching task difficult. It is better to tell students that a manoeuvre or problem, although difficult, is within their capabilities to perform or understand. Whatever the learning situation, it should affect the student positively and give them a feeling of satisfaction.

Intensity or arousal

A vivid, dramatic or exciting learning experience teaches more than does a routine or boring experience. This implies that the student will learn more from the real thing. In contrast to in-flight instruction, the classroom limits the amount of realism that can be brought into the teaching. Instructors should use imagination in the briefing. Photographs, mock-ups, and audio-visual aids can add vividness to classroom instruction.

Recency

The things most recently learned are best remembered. Instructors recognise recency when they carefully plan a summary of their pre-flight briefing or post-flight critique. You must repeat, restate or re-emphasise important points at the end of the lesson.

Feedback

Feedback on knowledge, skills and attitudes as learning takes place is important guidance for assessment on performance and progress. This feedback should be linked to the objectives of the lesson and focused on steps to take for next lesson or for improvement. It should guide the student in developing their own 'self-reflection' skills for assessing their own performance when flying solo.

How adults learn

One view of learning that is of particular importance to the flight instructor, is that proposed by MS Knowles[36] on how adults should be treated differently from children, based on their psychological differences.

- Children **need to know** what the teacher teaches if they want to pass.
- The child's **self-concept** is one of dependence on the teacher.
- The child's past **experience** is of little worth; it is the teacher's experience that matters
- The child is **ready** to learn when the teacher tells them to learn.
- The child is **orientated** toward subject matter.
- The child is **motivated** to learn by external forces, eg, grades, parents.

As flight instructors deal with adult or early adult education, how these differences affect adult learning is of some importance.

- Adults **need to know why**; they need to see a use for their learning.
- Adults have a **self-concept** of being responsible for their own lives. They resent and resist situations in which they feel others are imposing their wills on them.
- Adults have a greater quantity and quality of **experience**, therefore more emphasis is placed on techniques which use that experience, such as group discussion and simulation exercises.
- Adults become **ready** to learn when they see a need for learning in order to deal with real-life situations.
- Adults learn most effectively when the context is **orientated** so they can see that the learning will help them deal with tasks or problems.
- Adults are affected by external **motivation**, but they posses a far more powerful internal motivation through job satisfaction or self-esteem.

Recommended reading

For a fuller explanation of how these factors affect the adult learner, flight instructors are encouraged to read *The Adult Learner: A Neglected Species* by MS Knowles (1988), Chapter 3.

Perception

Initially, all learning comes from perceptions that are directed to the brain by one or more of the five senses. Psychologists have determined that normal individuals acquire about 75 percent of their knowledge through the sense of sight, 13 percent through hearing, 6 percent through touch, 3 percent through smell and 3 percent through taste. They have found that learning occurs most rapidly when information is received through more than one sense.

Perception involves more than receiving stimuli from the five senses. Perceptions result when a person gives meaning to sensations. People base their actions on the way they believe things to be, and this will depend on many factors within each person[8]. The experienced flight instructor, for example, will interpret engine rough running quite differently to an inexperienced student. Because perceptions are the basis of all learning, some of the factors that affect the perceptual process are discussed below.

Goals and values

Every experience and sensation that is funnelled into the brain is coloured by the individual's own beliefs and value structure. Spectators at a rugby game may 'see' an infraction or foul differently depending on which team they support. The precise kinds of commitments and philosophical outlooks that the student holds are important for you to know, since this knowledge will assist in predicting how the student will interpret experiences and instructions. For example, the student with an interest in crop-dusting will perceive instruction differently from those interested in airlines or helicopters. Motivation is also a product of a person's value structure; those things most highly valued are pursued while those of less importance are not.

Self-concept

A student's self-image, described as 'confident' or 'insecure' has a great influence on the perception process. How a person sees themselves is a powerful factor in learning. The student who attributes success to hard work, and failure to lack of effort, will perform better than a student who attributes success to luck and failure to lack of ability[9].

Time and opportunity

Learning depends on previous perceptions (experience) and the availability of time to relate new perceptions to the old. Therefore sequence and time available affect learning[1]. A student could probably stall an aircraft on the first attempt, regardless of previous experience. But the stall cannot be really learned unless some experience in normal flight has been acquired. Even with such previous experience, time and practice are needed to relate the new sensations and experiences associated with stalls in order to develop a perception of the stall. The length and frequency of an experience affect the learning rate. The training syllabus must provide time and opportunity. As a general guide for ab initio flight instruction little and often is best[10].

The element of threat

Fear adversely affects a student's perception by narrowing their perceptual field. The field of vision is reduced, for example, when an individual is frightened and all perceptual faculties are focused on the thing that has generated fear. Anxiety or worry (milder forms of fear) take up processing space in the working memory and may produce a "deficit in memory"[11], for example, during the initial practice of steep turns, a student may focus attention on the altimeter and completely disregard outside visual references. Anything an instructor does that is interpreted as threatening makes the student less able to accept the experience you are trying to provide. It adversely affects all the student's physical, emotional and mental faculties. Hence the extensive use, in flight instruction, of the follow-me-through exercise.

The student gains perception from the feel of control inputs but more importantly in the early stages, the student gains from the elimination of fear. You need to build a climate of confidence in which the student realises that you will not allow them to put the aircraft into a dangerous situation, and so the student's confidence in performing the manoeuvre grows. Learning is primarily a psychological process. As long as the student feels capable of coping with a situation, each new experience is viewed as a challenge.

Teaching is consistently effective only when those factors that influence perceptions are recognised and taken into account.

Insights

Insights involve the grouping of perceptions into meaningful wholes. To ensure that these occur, it is essential to help the student realise the way each piece relates to all the other pieces of the total pattern of the task to be learned[8].

As an example, in straight-and-level flight, in an aircraft with a fixed-pitch propeller, the RPM will increase when the throttle is opened and decrease when it is closed. RPM changes, however, can also result from changes in pitch attitude without changes in power setting.

Therefore engine RPM, power setting, airspeed and attitude are inter-related. Understanding the way in which each of these factors may affect all of the others, and understanding the way in which a change in any one of them may affect changes in all of the others, is imperative to true learning. This mental relating and grouping of associated perceptions is called insight.

Insights will almost always occur eventually, whether or not instruction is provided. Instruction, however, speeds this learning process by teaching the relationship of perceptions as they occur, thus promoting the development of insights by the student.

It is a major responsibility of the instructor to organise demonstrations, explanations and student practice so that the learner has the opportunity to understand the inter-relationship of experiences.

Pointing out the relationships as they occur, providing a secure and non-threatening environment in which to learn, and helping the student acquire and maintain a favourable self-concept are most important in the learning process.

Motivation

Motivation is the dominant force that governs the student's progress and ability to learn[12]. Motivations may be negative or positive, tangible or intangible, or subtle or obvious.

Negative motivations are those which engender fear. They are not characteristically effective in promoting efficient learning.

Positive motivations are provided by the promise or achievement of rewards. These rewards may be personal or social; they may involve financial gain, satisfaction of the self-concept, or public recognition. Some motivations that can be used to advantage by you include the desire for personal gain, the desire for personal security, the gaining of a sense of achievement, the desire for group approval, and the achievement of a favourable self-image.

The desire for personal gain, either the acquisition of things or position, is a basic motivation for all human endeavours. An individual may be motivated to dig a ditch or to design an aircraft solely by the desire for financial gain.

Students are like all other workers in wanting a tangible return for their efforts. If such motivation is to be effective, they must believe that their efforts will be suitably rewarded. These rewards must be constantly apparent to the student during instruction, whether they are to be financial, self interest or public recognition.

The student may not appreciate why they are learning a particular lesson. If motivation is to be maintained it is important that you ensure the student is aware of the applications of the lesson. This is usually achieved through the verbal introduction to the pre-flight brief. The attractive features of the activity to be learned can provide a powerful motivation. Students are anxious to learn skills that may be used, and if they can be made to understand how each learning task relates to their goals, they will be eager to pursue it.

The desire for personal comfort and security is a motivation that is often inadequately appreciated by instructors. All students want secure, pleasant conditions and states of being. If they recognise that what they are learning may promote this objective, their interest is easier to attract and hold. Insecure and unpleasant training situations retard learning.

Everyone wants to avoid pain and injury. Students are likely to learn actions and operations that they realise may prevent injury. This is especially true when the student knows that the ability to act correctly in an emergency results from adequate learning.

Group approval is a strong motivating force. Every person wants approval of friends and superiors[13]. Interest can be stimulated and maintained by building on this natural force. Most students enjoy the feeling of belonging to a group and are interested in attaining prestige among their fellow students.

Every person seeks to establish a favourable self-image. This motivation can best be fostered by you through the introduction of perceptions which are based on facts previously learned and which are easily recognised by the student as achievements in learning. This process builds confidence, and motivation is strengthened as a result.

Positive motivation is essential to learning. Negative motivations in the form of reproof and threats should be avoided with all but the most overconfident and impulsive students.

Slumps in learning are often due to slumps in motivation. Motivation does not remain at a uniform level and may be affected by outside influences, such as physical fitness or inadequate instruction. You must tailor instruction to maintain the highest possible level of motivation and should be alert to detect and counter lapses in motivation.

While the flight instructor must consider the motivation of students, it is also essential for the professional flight instructor to consider their own motivation. "The potential influence of an instructor is so great that it merits a career path and status" of its own, while "the use of flight instruction as a transient position to accumulate the hours needed to progress to an airline position is a hackneyed strategy and an unfortunate syndrome for the industry"[14].

Levels of learning

Learning may be accomplished at any of several levels. From the lowest to progressively higher levels of learning, these are:

- **rote learning**, the ability to repeat back something one has been taught without understanding or being able to apply it,
- **understanding** what has been taught,
- **application** of what has been learnt, and
- **correlating** what has been learnt with other things previously learned.

For example, a flight instructor may tell a beginning student pilot to enter a turn by banking the aircraft with aileron and applying sufficient rudder in the same direction to prevent slip or skid. A student who can repeat these instructions has learned by rote. This will not be very useful to the student if there is no opportunity to make a turn in flight (application) or if the student has no knowledge of the function of the aircraft controls (correlation).

Through instruction on the effect and use of the flight controls and experience in their use in straight-and-level flight, the student can develop these old and new perceptions into an insight on how to make a turn. At this point the student has developed an understanding of the procedure for turning the aircraft in flight. This understanding is basic to effective learning but may not necessarily enable the student to make a correct turn on the first attempt.

When the student understands the procedure for entering a turn, and has practised turns until an acceptable level of performance can be consistently demonstrated, the student has developed the skill to apply what has been taught.

Further understanding of the associated concepts are covered in the instructional techniques course syllabus when considering Bloom's Taxonomy for Cognitive (head), Psycho-motor (hands), and Affective (heart) Domains.

Learning a skill

Even though the process of learning has many aspects, the purpose of instruction is usually to learn a concept or skill. The process of learning a skill appears to be much the same whether it is a motor (physical) or mental skill. To provide an illustration of motor learning, follow the directions below:

- Write the word learning 15 times with your left hand (or right hand if you are left-handed). Try to improve the speed and quality of your writing.

In the learning task just completed, several principles of motor learning are involved and are discussed below.

Physical skills involve more than muscles

The above exercise contains a practical example of the multifaceted character of learning. It should be obvious that, while a muscular sequence was being learned, other things were happening as well. The perception changed as the sequence became easier. Concepts of how to perform the skill were developed and attitudes were changed[1].

Motivation

Where there is a desire to learn, rapid progress in improving the skill will normally occur[1]. Conversely, where the desire to learn or improve is missing, little progress is made. In the exercise above, it is unlikely that any improvement occurred unless there was a clear intention to improve. To improve, one must not only recognise mistakes, but also make an effort to correct them. The person who lacks the desire to improve is not likely to make the effort and consequently will continue to practise errors.

Patterns to follow

The best way to prepare the student to perform a task is to provide a clear, step-by-step example[1]. Therefore all exercises start with a demonstration. The demonstration is another way of stating the lesson objective – here is what you (the student) will be able to do at the end of this lesson. The demonstration is followed with a step-by-step follow-me-through example.

Perform the skill

Since you have now experienced writing a word with the wrong hand, consider how difficult it would be to tell someone else how to do it. Demonstrating how to do it will not result in a person learning the skill. Obviously practice is necessary[1]. As the student gains proficiency in a skill, verbal instructions mean more. Whereas a long detailed explanation is confusing to the student during early practice, comments are more meaningful and useful after the skill has been partially mastered.

Knowledge of results

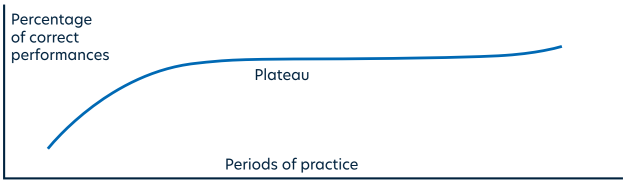
In learning some simple skills, students can discover their own errors quite easily. In learning others, such as complex flight manoeuvres, mistakes are not always apparent. Or the learner may know something is wrong but not know how to correct it. In either case, you provide a helpful and often critical function in making certain that the student is aware of their progress. They should be told as soon after the performance as possible[1], for they should not be allowed to practise mistakes. It is more difficult to un-learn a mistake and then learn it correctly, than it is to learn correctly in the first place. It is also important for students to know when they are right.

Progress follows a pattern

The experience of learning to write with the wrong hand probably confirmed what has been consistently demonstrated in laboratory experiments on skill learning. The first trials are slow and coordination is lacking. Mistakes are frequent, but each trial provides clues for improvement in subsequent trials. The learner modifies different aspects of the skill, how to hold the pencil, how to execute finger and hand movements. Skill learning usually follows the same pattern[15].

Figure 2

Typical progress pattern



The graph above shows a typical progress pattern. There is rapid improvement in the early trials, then the curve levels off and may stay level for significant periods of effort. Further improvement may seem unlikely. Such a development is a learning plateau, and it may signify any of a number of conditions. The learner may have reached capability limits, may be consolidating a level of skill, may have their interest wane, or may need a more efficient method for increasing progress. Keep in mind that the apparent lack of increasing proficiency does not necessarily mean that learning has ceased[16]. In learning motor skills, a levelling off process or plateau is normal and should be expected after an initial period of rapid improvement. This situation may cause impatience in the student. To avert discouragement, you should prepare them for this situation.

Duration and organisation of lessons

In planning for student performance, a primary consideration is the length of time devoted to practice. A beginning student reaches a point where additional practice is not only unproductive but may be harmful. When this point is reached, errors increase and motivation declines. The skilful instructor ends the learning experience before this point is reached. As a guide, when the basics of the manoeuvre have been achieved, it's time to end the lesson. For example, in the initial basic stall, when the student performs the actions of control column forward centrally and then full power, the basics of the manoeuvre have been achieved. It is for future lessons to build on this success, ie, aiming for coordination of control column and power, keeping straight and minimising height loss. As a student gains experience, longer periods of practice are profitable.

Evaluation versus critique

If an instructor were to evaluate the fifteenth writing of the word learning, only limited help could be given toward further improvement. You could judge whether the written word was legible, evaluate it against some standard, or perhaps assign it a grade. None of these would be very useful to a beginning student. The student could profit, however, by having someone watch the performance and critique it constructively to help eliminate errors. In the initial stages, practical suggestions are more valuable to the student than a grade.

As the instructor will not always be in the aircraft to give a judgement, self critique should be encouraged as a learning goal for the student.

Visualisation or imagery

"Research on motor skill learning has provided evidence for using mental practice"[1]. If you were to visualise yourself raising an arm out to the side, it would be possible to monitor activity in the deltoid muscles even though no physical movement had occurred. Imagery therefore has the effect of priming the appropriate muscles for subsequent physical action. The messages passed to the brain by the muscular system during visualisation are also retained in the memory. This means that physical skills can be improved even when they are only practised in the mind. The use of handouts and questionnaires on completion of the lesson can aid the student in reliving the experience in their mind.

Application of skill

The final and critical problem is use. Can the student use what has been learned? Two conditions must be present:

- The student must learn the skill so well that it becomes easy, even habitual, to perform.
- The student must recognise the types of situations where it is appropriate to use the skill. This second condition involves **transfer of learning**.

Transfer of learning

Transfer of learning is concerned with how well the learned material is applied in actual situations. For example, the student may have learned the symptoms of the approaching basic stall and the recovery technique. But are these symptoms recognised and acted on when observed in a turn?

Transfer cannot occur if the knowledge itself has not been initially mastered.

This points to a need to know a student's past experience and what has already been learned. In lesson planning, instructors should plan for transfer by organising lesson material to build on what the student already knows. Also, each lesson should prepare the student to learn what is to follow.

Recommended reading

Flight instructors are encouraged to read *Essentials of Learning for Instruction* by RM Gagne and MP Driscoll (2nd ed) (1988).

Forgetting and retention – theories of forgetting

Why people forget may point the way to helping them remember.

Disuse

A person forgets those things that are not used. But the explanation is not that simple. Experimental studies show, for example, that a hypnotised person can describe specific details of an event that would normally be beyond recall. Apparently the memory is there, locked in the recesses of the mind. The difficulty is summoning it up to consciousness[8].

Interference

From experiments, two conclusions about interference can be drawn:

- Closely similar material seems to interfere with memory more than dissimilar material.
- Material not well learned suffers most from interference[17].

Repression

Repression is the submersion of ideas into the unconscious mind. Material that is unpleasant or produces anxiety may be treated this way, but not intentionally. It is subconscious and protective. This type of forgetting is rare in aviation instruction.

Retention of learning

When a person forgets something it is not lost; rather it is unavailable for recall. Hunt and Poltrock offer the analogy of books in a library that are never removed from the shelves, whereas the index cards may be lost. Your problem then, is how to make certain that the student's learning is always available for recall. The following suggestions can help.

Teach thoroughly and with relevance. Material thoroughly learned is highly resistant to forgetting. Meaningful learning builds patterns of relationships in the student's consciousness. Whereas rote learning is superficial and is not easily retained, meaningful learning goes deep because it involves principles and concepts anchored in the student's own experience.

Long-term memory is enhanced if information is well encoded, put into several different files by being explained in different ways and thus well cross-indexed (association). Retention can be assisted by stimulation of interest.

Principles

The following are five significant principles that are generally accepted as having a direct application to remembering:

Praise

Responses that give a pleasurable return tend to be repeated. Absence of praise or recognition makes recall less likely.

Association

Each bit of information or action, which is associated with something already known by the student, tends to facilitate later recall.

Favourable attitudes

People learn and remember only what they wish to know. Without motivation there is little chance for recall. The most effective motivations are internal, based on positive or rewarding objectives.

Multiple senses

Although we generally receive what we learn through the eyes and ears, other senses also contribute to most perceptions. When several senses respond together, fuller understanding and a greater chance of recall is achieved.

Repetition

Each repetition gives the student an opportunity to gain a clearer and more accurate perception of the subject to be learned, but mere repetition does not guarantee retention. Practice gives an opportunity for learning but does not cause it. Three or four repetitions provide the maximum effect, after which the rate of learning and probability of retention fall off rapidly.

Human behaviour

By definition, learning is – a change of behaviour resulting from experience that persists. To successfully accomplish the task of helping to bring about this change, you must know why human beings act the way they do. Knowledge of basic human needs and defence mechanisms will aid you in organising student activities and in promoting a climate conducive to learning.

The relationship between you and the student has a profound impact on how much, and what, the student learns. Consider your own experiences with your first flight instructor. You probably thought your instructor was the best, and you probably strove to emulate and please your instructor. The power and impact of role modelling must not be underestimated. The instructor directs and controls the student's behaviour, guiding them toward their goals, by creating an environment that enables the student to help themselves.

To students, the instructor is a role model, a symbol of authority. Students expect you to exercise certain controls, and they recognise and submit to authority as a valid means of control. The controls the instructor exercises – how much – how far – to what degree – should be based on generalisations of motivated human nature.

- Physical and mental effort in work is as natural as play. Work may be a source of satisfaction and, if so, will be performed voluntarily.
- A human being will exercise self-direction and self-control in the pursuit of goals to which they have committed themselves.
- Commitment to a goal relates directly to the perceived reward for achievement, the most significant of which is satisfaction of ego.
- Shirking responsibility and lack of ambition are not inherent in human nature. They are usually the consequence of experience.
- The capacity to exercise a relatively high degree of imagination, ingenuity and creativity in the solution of common problems is widely, not narrowly, distributed in the population.
- Under the conditions of modern life, the intellectual potential of the average human being is only partially used.

Your ingenuity must be used in discovering how to realise the potential of the student. The responsibility rests squarely on you. If the student is perceived as lazy, indifferent, unresponsive, uncooperative or antagonistic, the cause may lie in your methods of control. The raw material is there, and the shaping and directing of it lies in the hands of those who have the responsibility of controlling it.

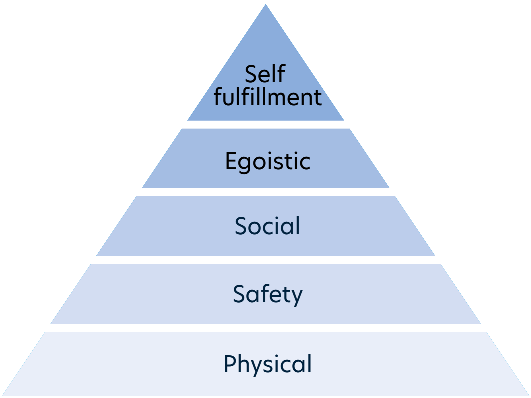
A productive relationship with the student depends on your knowledge of students, as human beings and of the needs, drives and desires they continually try to satisfy in one way or another.

Human needs

The needs of students, and of all humans, are given labels by psychologists and are generally organised in a series of levels. The 'pyramid of human needs' has been suggested by Abraham Maslow.

Figure 1

Maslow's hierarchy of needs



Physical needs

Individuals are first concerned with their need for food, rest, exercise and protection from the elements. Until these needs are satisfied to a reasonable degree, they cannot concentrate on learning or self-expression.

Once a need is satisfied, it no longer provides motivation. Therefore each individual strives to satisfy the needs of the next higher level.

Safety needs

Protection from danger, threat or deprivation are called safety or security needs. These needs, as perceived by the student, are real and will affect student behaviour.

Social needs

If individuals are physically comfortable and have no fear for their safety, their social needs then become the prime influence on their behaviour. These needs are to belong, to associate, and to give and receive friendship and love. Many studies have demonstrated that a tightly knit, cohesive group, under proper conditions, will be more effective than an equal number of separate individuals. As students are usually separated from normal surroundings, their need for association and for belonging will be more pronounced.

Egoistic needs

The egoistic needs will usually have a direct influence on the student-instructor relationship. These needs are two kinds:

- Those that relate to self-esteem through self-confidence, independence, achievement, competence and knowledge.
- Those that relate to reputation through status, recognition, appreciation and the deserved respect of peers.

Self-fulfilment needs

At the apex of the hierarchy of human needs are those for self-fulfilment, for realising your own potential, for continued development, and for being creative in the broadest sense. This need of a student should offer the greatest challenge to you. Aiding another in realising self- fulfilment is probably the most worthwhile accomplishment an instructor can achieve.

Defence mechanisms

Certain behaviour patterns are called defence mechanisms because they are subconscious defences against unpleasant situations. People use defences to soften feelings of failure, to alleviate feelings of guilt, and to protect feelings of personal worth and adequacy.

Although defence mechanisms can serve a useful purpose, they can also be hindrances. Because they involve some self-deception and distortion of reality, defence mechanisms do not solve problems. They alleviate symptoms, not causes. Common defence mechanisms are rationalisation, flight, aggression and resignation.

Rationalisation

If students cannot accept the real reasons for their behaviour, they may rationalise. This device permits them to substitute excuses for reasons. In addition, they can make those excuses plausible and acceptable to themselves. Rationalisation is a subconscious technique for justifying actions that otherwise would be unacceptable.

Flight

Students often escape from frustrating situations by fleeing, either physically or mentally. To flee physically, students may develop ailments that give them satisfactory excuses for removing themselves from frustration. More frequent is mental fleeing through daydreaming. Mental fleeing provides a simple and satisfying escape from problems. If students get sufficient satisfaction from daydreaming they may stop trying to achieve their goals.

Aggression

Everyone gets angry. Anger is a normal, universal human emotion. In a briefing room, classroom or aircraft, extreme anger is relatively infrequent. Because of social strictures, student aggression is usually subtle. Students may ask irrelevant questions or refuse to participate in class activities.

Resignation

Students may become so frustrated that they lose interest and give up. The most common cause of this takes place when, after completing the early phase of a course without grasping the fundamentals, a student becomes bewildered and lost in the advanced phase. From that point learning is negligible, although the student may go through the motions of participating.

The instructor’s role in human relations

To minimise student frustration and achieve good human relations are basic instructor responsibilities.

Keep students motivated

Students gain most from wanting to learn rather than being forced to learn. Often students do not realise how a particular lesson or course can help them reach an important goal. Each lesson must have relevance. When they can see the benefits or purpose of a lesson or course, their enjoyment and their efforts will increase.

Keep students informed

Students feel insecure when they do not know what is expected of them or what is going to happen to them. For example, consider your own feelings before your first basic stall lesson.

Instructors can minimise such feelings of insecurity by telling students what is expected of them and what they can expect, not just the control inputs to use.

Approach students as individuals

When instructors limit their thinking to a group without considering the individuals who make up that group, their effort is directed at an average personality which really fits no one[18]. After giving the same lesson several times, it is easy for you to overlook this aspect.

Each individual has a personality which is unique and which should be constantly considered.

Give credit when due

When students do well, they wish their abilities and efforts to be noticed. Otherwise they become frustrated. Praise from you is usually ample reward and provides incentive to do even better. Praise given too freely, however, becomes valueless.

Constructive feedback

Although it's important to give praise and credit when deserved, it's equally (not more) important to identify mistakes and failures. However, to tell students that they have made errors and not provide explanations does not help them. Errors cannot be corrected if they are not identified, and if they are not identified they will probably be perpetuated through faulty practice. If the student is briefed on the errors made, and is told and shown how to correct them, progress and accomplishment can be made.

Be consistent

Students want to please their instructor. Therefore, students have a keen interest in knowing what is required to please you. If the same thing is acceptable one day and not the next, the student becomes confused. Your philosophy and actions must be consistent. This often leads to a desire by the student to fly with only one instructor.

Admit errors

No one, including the students, expects an instructor to be perfect. You can win the respect of students by honestly acknowledging mistakes. If you try to cover up or bluff, the students will often sense it. Such behaviour destroys student confidence in you. If in doubt about some point, you should admit it. You should report back to the student after seeking advice from the supervising instructor, CFI, or recognised texts.

Good human relations promote effective learning.

Effective communication

Communicating, for an instructor, is an essential skill. Improving communication skills depends on an understanding of the process. In this chapter we look at the elements of the communication process and the barriers to successful communication.

Basic elements of the communication process

Communication takes place when one person transmits ideas or feelings to another person or group. Its effectiveness is measured by the similarity between the idea transmitted and the idea received[19].

The basic process of communication is composed of three elements:

- The source – sender, speaker, writer, instructor, transmitter, etc.
- The symbols – words, signs, actions, music, etc.
- The receiver – listener, reader, student, etc.

These elements are interrelated, and that which affects one influences the others. If a listener has difficulty in understanding the symbols a speaker is using and indicates confusion, the speaker may become puzzled and uncertain, losing control of ideas. Communication effectiveness is diminished. On the other hand, when a listener reacts favourably, a speaker is encouraged, and force is added to communication. Communication is a complicated two-way process.

The source

The effectiveness of a person acting in the role of communicator is related to at least three basic factors.

First, their ability to select and use language influences their ability to select meaningful symbols for the listener or reader. For example, if you want to teach Greek it's useful to know the Greek alphabet.

Second, communicators consciously or unconsciously reveal attitudes about themselves, about the ideas they are trying to transmit, and about their receivers. These attitudes must be positive if they are to communicate effectively. They must indicate that they believe their message is important. Communicators must make it clear to their listeners or readers that they believe there is a need to know the ideas presented.

Third, successful communicators speak or write from a broad background. Communicators must exercise great care to make certain they communicate ideas and feelings that are meaningful to their receivers. Often a speaker or writer will depend on a narrow, highly technical or professional background, with its associated vocabulary, which is meaningful only to others of a similar background.

Reliance on technical language to express ideas often impedes effective communication.

Symbols

At its basic level, communication is achieved through the use of simple oral and visual codes. The letters of our alphabet when translated into words are a basic code. Common gestures and facial expressions and body language form another[20]. Words and gestures may be projected in isolation, but ideas are communicated only when symbols are combined into meaningful wholes as sentences, paragraphs and chapters. Each part is important for effective communication.

Communicators must carefully select ideas if they are to convey messages which receivers can react to and understand. They must determine which ideas are best suited to starting and concluding the communication, and which ideas clarify, emphasise, define, limit and explain – all of which form the basis for the effective transmission of ideas from source to receiver.

The development of ideas culminates in the choice of medium best suited for transmission. Most frequently, communicators select the channels of hearing and seeing. Occasionally, the channel of feeling, by touching or manipulating, can be used effectively. The most successful communicator, however, uses a variety of channels.

Receiver

Communication succeeds only in relation to the reaction of the receiver.

When the receivers react with understanding and change their behaviour accordingly, then – and only then – has communication been effective[21]. To understand effective communication, at least three characteristics of receivers must be understood[19].

First, the receiver's ability to question and comprehend the ideas that have been transmitted. Communicators can capitalise on this by providing an atmosphere which encourages questioning. Communication is most effective when the **feedback** loop is available to obtain further clarity to ensure the message is correctly received.

Second, the receiver's attitude, which may be one of resistance, willingness or passive neutrality. Whatever the attitude, communicators must gain the receiver's attention and then retain it. Generally, the more varied the communicative approach the more successful they will be in this respect.

Third, the receiver's background, experience and education define the target at which communication must be aimed. Communicators must assess their receiver's knowledge and use that assessment as a guide for selecting techniques for transmission. The major barriers to effective communication are usually found in this particular area.

Barriers to effective communication

The nature of language and the way it is used often lead to misunderstandings. These misunderstandings stem primarily from three barriers to effective communication:

- Lack of a common core of experience
- Confusion between the symbol and the thing symbolised
- Use of abstractions.

Lack of a common core of experience

Probably the greatest single barrier to effective communication is the lack of common experience between communicator and receiver. Communication can be effective only to the extent that the experiences – physical, mental or emotional – of the people concerned are similar[22]. Words do not transport meanings from speaker to listener in the same manner as a truck carries bricks from one location to another. Words never carry precisely the same meaning from the mind of the communicator to that of the receiver.

Consider your own experience as a communicator. Recall telling someone of your experiences on holiday. Although you tried to describe the experience vividly, you may have felt that the receiver didn't get the full picture of your holiday. Words, spoken or written, do not transfer meanings; they are merely stimuli that a communicator uses to arouse a response in the receiver. The nature of the response is determined by the receiver's past experience with the words and the things to which they refer[20]. These experiences give the words their meaning – which is in the mind of the receiver, not in the words themselves.

Words cannot communicate meaning unless the listener or reader has had some experience with the concepts or objects to which the words refer[23]. Consider the effect of your communication if your listener had never been on a holiday.

Confusion between the symbol and the thing symbolised

Words are simply representations. They represent anything that exists or that is experienced. Consider language as a map. A useful map accurately represents some specified territory; language should correspond to the objects or concepts that it represents. Like a map that contains errors, a statement that contains inaccuracies implies a relationship that does not exist.

Use of abstractions

Concrete words refer to objects that we can experience directly. Abstract words, on the other hand, stand for ideas that cannot be directly experienced, for things that do not call forth mental images in the mind of the receiver. For example, assuming a similar core of experience, if a communicator is discussing a particular fighter aircraft and refers to it as the stealth-fighter, the listeners immediately get a mental image of this aircraft (clearly the accuracy of that image will be affected by experience). The name stealth-fighter represents a concrete reality that can be seen, heard and touched. If, however, the communicator uses just the words fighter aircraft the listeners do not necessarily form a specific mental image of the stealth-fighter because there are a number of aircraft that fit that description. If the communicator uses just the word aircraft, the term is so abstract that the listeners cannot form a mental image of the stealth-fighter at all.

Abstract words do not bring forth specific items of experience in the minds of receivers. Although abstractions are convenient and useful, they can lead to misunderstandings. When abstractions are used in communication, they should be linked with specific experiences through examples and illustrations. The level of abstraction should be reduced wherever possible by using concrete and specific words[24]. In this way the communicator narrows and gains better control of the image produced in the mind of the listener or reader.

The teaching process

Effective teaching must be based on the principles of learning discussed in **Learning theory**. The learning process does not seem to be naturally divisible into a definite number of steps.

Sometimes it occurs almost instantaneously, as when a child learns about heat from touching a hot stove. In other cases, learning is acquired only through long, patient study and diligent practice.

A close examination of the teaching process reveals that different recognised authorities specify a varying number of steps. Here we will concern ourselves only with the four basic steps[25] that can be applied either to ground lectures or flight instruction. They are:

- Preparation
- Presentation
- Application
- Review and evaluation.

Preparation

For each lesson or instructional period, you must refer to the syllabus and determine what can reasonably be covered in the time available. From this information, the objective of the lesson is set. The objective is a statement of what the student will be able to do on completion of the lesson[26].

For an objective to result in the desired learning outcome it must:

- **Be achievable**. The objective must be something the student could reasonably be expected to be able to do, given their past experience.

  If the student cannot achieve the objective, motivation may be adversely affected.

- **Be observable**. The objective must be observable by both student and instructor. For example, "The student will know the symptoms of the approaching stall" is not an observable objective, whereas "The student will state the symptoms of the approaching stall" is observable.

  The observed performance is what evaluation should be based on.

- **Be measurable**. The objective must have some limits by which both you and student can measure acceptable performance[27]. For example, "State the symptoms of the approaching stall in the correct order without error".

  The parameters stated need not be perfection or final test parameters. They should relate directly to what it is you expect the student to be able to do at the end of this lesson.

In addition a statement may be made as to the conditions under which the student must perform, for example, whether by using a briefing handout or from memory.

In summary, in the objectives you spell out what the student is expected to do, how well, and under what conditions[28]. In your instructional techniques course, this will be described as Performance, Standard, and Conditions.

Care must be taken in preparing an objective to ensure that it accurately describes the desired learning outcome. The objective "to state the symptoms" is aimed at the knowledge level and could be achieved without the student ever having experienced a stall. Therefore, assuming the student achieved the above objective under the conditions stated, the following learning outcomes would result:

- the student can read a list from top to bottom; or
- the student has memorised a list from top to bottom.

To write a lesson objective, ask yourself these questions:

- What is it I expect the student to be able to do at the end of this lesson?
- How will I know that they are doing it?
- How well should they do it? and, if applicable,
- Under what conditions?

Preparing objectives in this way not only gives the student a clear idea of what is expected of them at the end of the lesson, but, more importantly, also focuses your attention directly on what it is you want your student to achieve as a result of your instruction.

To achieve a desired learning outcome, multiple objectives may be required. If you find you have more than three objectives for a lesson, serious consideration should be given to breaking the lesson down into smaller units.

Preparation must involve the development of a detailed written lesson plan if the instructional period is to be effective. The lesson plan is your statement of lesson objectives, the procedures and facilities to be used in presenting it, and the specific goals to be attained. The development of lesson plans by instructors signifies, in effect, that they have taught the lessons to themselves before teaching the lesson to students. The use of a lesson plan should:

- Assure a wise selection of material and eliminate unimportant details.
- Ensure due consideration is given to each part of the lesson.
- Aid the presentation of material in a suitable sequence.
- Give the inexperienced instructor confidence.

Preparation should also include pre-lesson handouts[29] or assigned reading to be completed by the student before the lesson.

As part of the preparation, you should make certain that all necessary supplies, materials and equipment are readily available and that the equipment is operating properly before the student arrives.

Presentation

It is your presentation of the knowledge and skills that make up the lesson. The choice of the method of presentation is determined by the nature of the subject matter and the objective.

The **lecture** method is suitable for presenting new material, for summarising ideas and for showing relationships between theory and practice. For example, it is suitable for the presentation of a ground school lesson on aircraft weight and balance. This method is most effective if accompanied by instructional aids and training devices. In the case of a lecture on weight and balance, a whiteboard could be used effectively, so could a seesaw.

The **demonstration-performance** method is desirable for presenting a skill, such as use of the flight navigation computer. Great care must be taken in using this method, to ensure that the demonstration follows the correct steps in the proper order, so the student gets a clear picture of each separate part of the operation.

Application

Application is the student's use of the ideas presented by you. This is where you discover if the images transmitted are similar to those received by the student, and if transfer of learning has occurred. In a classroom situation, the student may be asked to explain the new material, or to perform an operation. For example, at the end of a lesson on the use of the navigation computer, the student may be asked to work a flight-planning problem involving the computation of groundspeed and drift.

In classroom and flight instructing situations, portions of your explanation and demonstration are alternated with student practice. It is rare that you complete an explanation and demonstration and then expect the student to complete the performance.

It is very important that the student perform the manoeuvre or operation the right way the first few times, for this is when habits are established. Faulty habits are difficult to correct.

The emphasis is on the correct sequence – not the speed at which it is performed. Speed of performance may be an important goal, but it should not take precedence in the early stages of instruction.

After reasonable competence has been attained, the manoeuvre or operation should be practised until correct performance becomes almost automatic.

Review and evaluation

Review and evaluation is an integral part of each classroom or flight lesson. Before the end of the instructional period, you should review what has been covered and require students to demonstrate the extent to which the lesson objectives have been met.

Evaluation may be informal and noted only for use in planning the next lesson, or it may be recorded to certify the student's progress. In either case, the student should be aware of their progress.

In flight training, you must remember that it is difficult for students to obtain a clear picture of their progress, since they have little opportunity for a direct comparison with others, especially in the early phases of training. The students recognise that they are in a competitive situation unlike any previously experienced. The unseen competitor is that intangible competency which must be achieved. The student's own evaluation can only be subjective. Direct comparisons for them are only possible with the performance of the instructor. Only you can provide a realistic evaluation of performance and progress.

In addition to knowledge and skills learned during the period just completed, each lesson should review things previously learned. If faults not associated with the present lesson are revealed, they should be pointed out. Such corrective action as is practical within the limitations of the situation should be taken immediately; more thorough remedial action must be included in future lesson plans.

The evaluation of student performance and accomplishment during a lesson should be based on the stated objective[30]. For example, in the taxiing briefing, if you have stated the objective that the student should watch for potholes, then you cannot evaluate the student's performance as poor when the student taxies through a pothole, especially if the student states that they saw the pothole.

Recommended reading

Effective Aviation Instruction by RA Telfer (1993) in *Aviation Instruction and Training*[14] p219-236

Preparing Instructional Objectives[26] by RF Mager (1984)

Teaching methods

The instructor's skill is determined to a large degree by the ability to organise material and to select and utilise a teaching method appropriate to a particular lesson. Of the various teaching methods in common use, only the lecture method, the guided discussion and the demonstration-performance method will be covered here. The pre-flight briefing will be discussed at length in the Briefings section.

There is no definite line of division between these methods; some material requires the use of more than one method or a combination of methods[25]. For example, a demonstration of how to use the aircraft radio, followed by a thorough explanation, is essentially a lecture.

The use of programmed instruction will also be discussed, as many organisations employ the principles of this type of instruction, primarily through computers when it is known as Computer-Based Training (CBT).

Organising material

Regardless of the teaching method used, you must organise the material in a logical sequence[31]. One effective way to organise the lesson, and the simplest, is:

- Introduction
- Development
- Conclusion[25]

Appendix A expands on this sequence.

Introduction

The introduction serves several purposes:

- To establish common ground between you and the students
- To capture and hold the attention of the student or group

- To establish the objectives of the lesson
- To indicate what material is to be covered and how this relates to the entire course
- To point out why the student should learn the material and what benefits the student can expect
- To establish a receptive attitude toward the lesson
- To lead into the lesson development.

The introduction should be free of stories or incidents that do not help the students focus their attention on the lesson objective. Also, a long or apologetic introduction should be avoided, as it will dampen student interest in the lesson. The introduction sets the stage for learning by gaining the student's attention, providing motivation and giving an overview of the material to be covered and its relevance to the course goals.

Attention

For information to be perceived, it first must be attended to[32]. Gaining and maintaining the student's attention, therefore, is of prime importance to you. One of the most effective methods is novelty[24]. For example, a lesson on aircraft weight and balance might start with two students, of obviously different weights, being asked to balance out a see-saw. Or you might make an unexpected or surprising statement, eg, "for most aircraft a rearward C of G increases airspeed!" and then inviting debate by asking why. Or you might begin by telling a true story of an incident that relates to the subject and thereby establishes a background or reason for learning. No matter how you introduce the lesson, the main concern should be to gain the student's attention and focus it on the subject[33].

Motivation

The introduction should offer the students specific reasons for needing to be familiar with, to know, to understand, to apply or to be able to perform whatever they are about to learn. This motivation should appeal to each student personally.

Overview

Every lesson introduction should contain an overview that tells the student or group what is to be covered during the lesson. A clear, concise presentation of the objective and the key ideas is absolutely critical, for it gives the student a road map of the route to be followed.

Development

The development of the lesson is the main part. Here you develop the subject matter in a manner that helps the students achieve the desired outcome or objective.

You must organise the material logically to show the relationships of the main points[34]. Usually these primary relationships are shown by developing the main points in one of the following ways[25]:

- from past to present
- from simple to complex
- from known to unknown
- from most to least frequently used.

From past to present

In development from past to present, the subject matter is arranged chronologically. This is most suitable when history is an important consideration, eg, when tracing the development of GPS (Global Positioning System).

From simple to complex

The simple to complex pattern helps you lead the student from simple facts or ideas to an understanding of complex concepts. In studying lift, for example, the student might begin by considering the action of a river as it enters and leaves a narrow gorge – and finish with the lift formula.

From known to unknown

By using something the student already knows you can develop concepts. For example, in discussing the properties of the magnetic compass you could revise the previously learned properties of a simple bar magnet.

From most to least frequently used

Some information or concepts are common to all who use the material. This pattern starts with the most common use before progressing to rarer ones. For example, dead-reckoning techniques for navigation are learnt before applying them to lost procedures.

Under each main point in a lesson the subordinate points should lead naturally from one to another. With this arrangement, each point leads logically into, and serves as a reminder of, the next. Meaningful transitions keep the students oriented, aware of what they have covered and what is to come[25].

Organising a lesson so that the students will grasp the logical relationships of ideas is not an easy task. The use of a lesson plan provides guidance on how to link ideas in a logical sequence. This type of organisation is necessary if the students are to learn. Poorly organised information is of little or no value to the student.

Conclusion

An effective conclusion retraces the important elements of the lesson and relates them to the objective. This review and wrap-up of ideas reinforces the student's learning and improves retention. It will generally include some assessment of whether or not the learning has been achieved.

No new ideas should be introduced in the conclusion.

Lecture method

You should know how to prepare and present a lecture and should understand the advantages and limitations of this teaching method.

The lecture is used primarily to introduce students to a new subject, but it is also a valuable method for summarising ideas, showing relationships between theory and practice, and re- emphasising main points[35]. The lecture method is adaptable and has several advantages.

Lectures may be given to either small or large groups, they may be used to introduce a complete training program or a single unit of instruction, and they may be combined with other teaching methods to give added meaning and direction.

The success of a lecture depends on your ability to communicate effectively as well as the ability to plan, develop and review the lesson.

In other methods of teaching (demonstration-performance, guided discussion) the instructor receives direct reaction from the students in the form of verbal or motor activity. During a lecture, however, feedback is not as direct and is therefore harder to interpret. You must develop a keen perception for subtle responses from the class (facial expressions, apparent interest or disinterest) and be able to interpret the meaning of these reactions and adjust the lesson accordingly.

Planning the lecture

The competent instructor knows that careful preparation is a major factor in the successful presentation of a lecture. Preparation should start well in advance of the presentation.

Four steps should be followed in the planning phase of preparation:

- Establish the desired outcome and therefore the objective
- Research the subject
- Organise the material
- Plan interactive classroom activities.

Developing the lecture

In supporting key points or ideas in the lesson, you must work on the assumption that the student may neither believe nor understand the points to be covered. In developing the lesson you should use the recommended text for the subject as well as statistics, comparisons and meaningful examples.

After completing the preliminary planning and writing the lesson plan, you should rehearse the lecture to build self-confidence. During rehearsal the mechanics of using notes, visual aids and other instructional techniques can be smoothed out. You should have your supervisor attend the practice sessions and observe the presentation critically. This critique will help you judge the adequacy of supporting materials and visual aids.

Suitable language

During the lecture, simple rather than complex words should be used whenever possible. Errors in grammar and vulgarisms detract from an instructor's dignity and reflect upon the intelligence of the students.

If the subject includes technical terms, you should clearly define each one so that no student is in doubt about its meaning[12]. Whenever possible, you should use specific rather than general words. For example, the specific words "a leak in the fuel line" tell more than the general term "mechanical defect".

Another way you can enliven the lecture is to use sentences of varying length. Too many short sentences result in a choppy style; long sentences, unless carefully constructed, are difficult to follow. To ensure clarity and variety, you should use a mixture of short and medium length sentences[25].

Whatever the style adopted by you, a display of enthusiasm will greatly affect the success of any presentation. "Probably the best teachers of adults are people who are enthusiastic amateurs in their subject - at least, amateurs at teaching it"[36].

Delivery methods

You can deliver a lecture in one of four ways, by:

- reading written notes
- reciting memorised material
- speaking without notes from an outline
- speaking impromptu without preparation.

The lecture is probably best delivered by speaking without notes from an outline. You speak from a mental or written outline but do not read or memorise the material to be presented. Because the exact words with which to express an idea are left to the moment, the lecture is more personalised and provides more opportunity for enthusiasm, than one which is read or spoken from memory. Since you talk directly to the students, rather than head down reading from notes, the reactions of the students can be readily observed, and adjustments can be made to their responses.

You have better control of the situation, can change the approach to deal with any situation as it arises, and can tailor each idea to suit the individual responses of the students. For example, if you realise from their puzzled expressions that a number of students fail to grasp an idea, that point can be elaborated upon until the reactions of the students indicate that they understand.

Overall, this method reflects your personal enthusiasm and is more flexible than other methods. For these reasons it is likely to hold the interest of the students.

Use of notes

An instructor who is thoroughly prepared can usually speak effectively without notes. If the lecture and outline have been carefully prepared and rehearsed there should be no real difficulty. However, if your preparation has been limited, you may find it necessary to use notes.

Notes do have certain advantages. They assure accuracy, jog the memory, and dispel the fear of forgetting. An instructor should not, however, be overly dependent on notes. Use them sparingly and unobtrusively, but make no effort to hide them from the students. Notes should be written legibly or typed, and they should be placed on the lectern where they can be consulted easily, or held if you walk about the platform.

Formal versus informal lectures

The lecture may be conducted in either a formal or informal manner.

Learning is best achieved if students participate actively in a friendly, relaxed atmosphere. Therefore, use of the informal lecture, which includes active student participation, is encouraged. A formal lecture, however, is still to be preferred on some occasions, such as introducing new subject matter.

You can achieve active student participation in the informal lecture through the use of questions[27]. In this way, the students are encouraged to make contributions that supplement the lecture. You can use questions for one or more of the following purposes:

- to determine the experience and background of the students
- in order to tailor the lecture to them,
- to add variety and stimulate interest, or
- to check student understanding.

It remains your responsibility to plan, develop and present the lesson. The students should not be relied on for any significant portion of the lesson development.

Advantages of the lecture

In a lecture, you can present many ideas in a relatively short time. Facts and ideas that have been logically organised can be concisely presented in rapid sequence. Lecturing is the most economical teaching method in terms of the time required to present a given amount of material. It is also a convenient method for large groups.

The lecture can be used to ensure that all students have the necessary basic information background to learn a new subject[12]. You can offer students with varied backgrounds a common understanding of principles and facts. For example, in learning about aircraft performance, the factors affecting aircraft take-off and landing distances could be covered in a lecture, before moving on to a demonstration-performance on the use of take-off and landing performance charts.

If students do not have the time required for research or access to reference material, information they need can be presented in a lecture. The lecture can usefully and effectively supplement other teaching methods. A brief introductory lecture can give direction and purpose to a demonstration. For example, a lecture on the triangle of velocities could precede a demonstration of the use of the navigation computer. A lecture can also prepare students for a discussion by telling them something about the subject matter to be covered. For example, the effects of fatigue on pilot performance followed by discussion on individual experiences.

Disadvantages of the lecture

As a teaching method the lecture cannot provide for all desired learning outcomes. Motor skills can not be learned by listening to a lecture.

Too often the lecture does not provide for student participation and, as a consequence, many students willingly let you do all the work.

Learning is an active process, and the lecture tends to foster passiveness and teacher-dependence on the part of the students[12].

The lecture does not enable you to estimate the student's progress before additional material is introduced. Within a single period, you may unwittingly present more information than students can absorb. The lecture method provides no accurate means of checking student learning.

Instructors find it difficult to hold the attention of all the students throughout a lecture[37]. The successful lecture relies heavily on your skill in speaking.

Recommended reading

53 Interesting Things to do in Your Lectures[33] by G Gibbs et al (1991)

Planning an Instructional Sequence[27] by WJ Popham et al (1970)

Guided discussion method

In contrast to the lecture, where you provide information, the guided discussion relies on the students to provide ideas, experiences, opinions and information. An instructor may use this method after the students have gained some knowledge and experience, during classroom periods or pre-flight and post-flight briefings. This method is particularly applicable to CPL and your own instructor training.

Fundamentally, the guided discussion is the reverse of the lecture method. You should aim to draw out what the students know, rather than telling them. You must remember that the more intense the discussion and the greater the participation, the more effective the learning will be. You must be sure that all members of the group follow the discussion, and that all are treated impartially. You must encourage questions, exercise patience and tact, redirect questions to other members of the group where possible, and comment on all responses.

Use of questions

In the guided discussion, learning is produced through the skilful use of questions[38]. The instructor often uses a question to open up an area for discussion, which may be directed at the entire group to stimulate thought or a response from each group member. Its purpose is to get discussion started. For example, "What can you tell me about lift?"

The rhetorical question is similar in nature because it also spurs group thought. For example, "What is lift?" you answer the rhetorical question, however, and it is more commonly used in the lecture. After the discussion develops, you may ask a follow-up question to guide the discussion. For example, "What is the relationship between true airspeed and lift?" The reasons for using a follow-up question may vary. You may want a student to explain something more thoroughly, or may need to bring the discussion back to a point from which it has strayed. If, however, a response is desired from a specific individual, perhaps to encourage participation, a direct question may be asked of that student. Be certain to acknowledge the response.

Rather than give a direct answer to a student's question, you may elicit the answer by redirecting the original question (or a modified version of it) back to the individual, to another student, or to the entire group.

Questions used to evaluate or measure student learning should require a specific answer relating to the material covered. For example, "If true airspeed is doubled, and everything else remains constant, by how much will the lift increase?" The question, "Any questions?" should rarely, if ever, be used.

Questions should:

- Have a specific purpose
- Have a clear meaning
- Contain a single idea
- Stimulate thought
- Require definite answers
- Relate to previously taught information.

Planning a guided discussion

Planning a guided discussion is similar to planning a lecture. In addition the following suggestions[27] may help:

Select a topic the students can profitably discuss

Unless the students have some knowledge to exchange with each other, they cannot reach the desired learning outcomes by the discussion method. If necessary, set assignments that will give the students an adequate background for discussing the lesson topic. For example, "Research factors which may influence the successful outcome of an engine failure after take-off".

Establish a lesson objective and desired learning outcomes

Through discussion, the students develop an understanding of the subject by sharing knowledge, experiences and backgrounds. Consequently, the objective is normally stated at the understanding level of learning. For example, "To explain the factors which may influence the successful outcome of an engine failure after take-off". The learning outcomes should stem from and be related to the objective. For example, "Recognise the value of a pre-take-off emergency brief, develop situational awareness and be aware of aircraft performance limitations".

Conduct adequate research to become familiar with the topic

While researching, you should always be alert for ideas on the best way to tailor a lesson for a particular group of students. For example, a lecture or discussion on the use of the aircraft radio could profitably be combined with a visit to the control tower. During the research process, you should collect (or set an assignment for the students to collect) appropriate background reading material. Such material should be well organised and based on the fundamentals.

Organise the main points of the lesson in a logical sequence

The guided discussion has three main parts – introduction, discussion and conclusion. The introduction consists of gaining attention, motivation and overview. During the discussion, you should ensure that the main points build logically to the objective, minimising the possibility of a rambling presentation. The conclusion consists of the summary and re-motivation.

Plan at least one question for each desired learning outcome

In preparing questions, you should remember that the purpose is to bring about discussion, not merely to get answers. Questions that require only short answers such as "yes" or "four" should be avoided[25]. Questions framed to encourage discussion usually start with "how" or "why". For example, "Why does altitude affect take-off performance?" rather than "Does altitude affect take-off performance?" The first question invites discussion, the second, an answer of "yes".

Student preparation

"Involving the student so that learning becomes co-operative produces superior results to those achieved by competitive or individual approaches."[14] It is your responsibility to encourage students to accept responsibility for their learning, by contributing to and profiting from, the discussion. Students should be made aware of the lesson objective and be given pre-lesson research or study to complete.

If you have no opportunity to assign preliminary work, it is advisable to give the students a brief general overview of the topic during the introduction. Under no circumstances should students without some background in a subject be asked to discuss that subject.

Guiding a discussion

Introduction

A guided discussion is introduced in the same manner as a lecture. The introduction should include an attention step, a motivation step and an overview of key points. To encourage enthusiasm and stimulate discussion, you should show enthusiasm, "it's infectious"[14], and create a relaxed, informal atmosphere. Each student should be given the opportunity and encouragement to discuss aspects of the subject. You must make the student feel a personal responsibility to contribute, and that their ideas and active participation are wanted and needed. "The instructor's job is not as simple as ensuring that the syllabus is presented to the student."[14]

Discussion

You open the discussion by asking one of the prepared questions. After asking a question you should give the students a chance to react[25]. You have the answer in mind before asking the question, but the student has to think about the question before answering. You must be patient while the students figure out the answer. It takes time to recall data, word an answer or think of an example. The more difficult the question, the more time the student will need to produce an answer.

Sometimes students may not understand the question. Whenever you detect this, the question should be restated in a slightly different form. Alternatively, the question may need to drop down a level in Bloom's Taxonomy for cognitive domain.

Once the discussion is under way, you should listen attentively to the ideas, experiences and examples contributed by the students during the discussion. During preparation, you will have anticipated the responses that indicate the students have a firm grasp of the subject. As the discussion proceeds, you may find it necessary to stimulate the students to explore the subject in greater depth or guide the direction of the discussion and encourage them to discuss the topic in more detail. By using how and why follow-up questions, you should be able to guide the discussion toward the objective of understanding the subject.

Once the students have discussed the ideas that support the objective, you should summarise what the students have accomplished.

In a discussion lesson, an interim summary is one of the most effective tools available to you to bring ideas together. In addition, the interim summary may be used to keep the group on the subject or divert the discussion to another member.

Throughout the discussion it is desirable to record ideas, facts and agreements so that the group can see relationships and the progress that has been made. The whiteboard is suitable for this purpose. Brainstorming is a special version of this process, where all ideas on a subject – no matter how weird – are recorded without criticism and then discussed by the group. This method is useful for creating an informal, relaxed atmosphere. The use of drop sheets in small groups is another useful tool in capturing information that may benefit from longer exposure on the wall compared to cleaning the board.

Conclusion

A guided discussion is closed by summarising the material covered. In the conclusion, you should tie together the various points or topics discussed and show the relationships between the facts brought forth and the practical application of these facts[25]. As an example, in concluding a discussion on engine failure after take-off, an instructor might give statistical results of the attempted turn back as against other options.

The summary should be brief but not to the point of incompleteness. If the discussion revealed that certain areas are not understood by one or more members of the group, you should clarify this material.

Demonstration-performance method

The demonstration-performance method is used extensively in flight instruction during the air exercise and is based on the principle that we learn by doing. Students learn physical or mental skills by performing those skills under supervision. An individual learns to write by writing, to weld by welding, and to fly an aircraft by performing flight manoeuvres.

Great care must be taken in using this method, to ensure that the demonstration follows the correct steps, in the proper order, so that the student gets a clear picture of each part of the operation. The demonstration-performance method has five essential phases:

- Explanation
- Demonstration
- Instructor supervision
- Student performance
- Evaluation.

Explanation

"If telling was the same as teaching we would all be so smart we could hardly stand it."[39]

In flight training, the explanation phase is served by the pre-flight briefing. Explanations must be clear, pertinent to the objectives of the lesson, and based on the known experience and knowledge of the students.

You must convey to the student the precise actions they are to perform, the expected result of those actions, and the possible effects of those actions on the student.

Before leaving this phase, you should ask questions so as to determine if there is understanding of the procedure to be followed.

Demonstration

Before the demonstration, you direct the attention of the student to no more than two items to be closely observed during the demonstration. These are the one or two items you consider vital for the execution of the skill. For example, in the steep turn, "note the aircraft nose attitude and bank angle in relation to the horizon". Then you must show the student the actions necessary to perform the skill.

As little unrelated activity as possible should be included in the demonstration if the student is to clearly understand that you are accurately performing the actions previously explained. Therefore, there is no verbal patter during this phase. The demonstration serves as a physical restatement of the objective, "here is what you will be able to do at the end of this lesson".

If, because of unanticipated circumstances, the demonstration does not closely conform to the explanation, the discrepancy should be immediately acknowledged and explained.

Instructor supervision, student performance

Instructor supervision and student performance involve separate actions, but they are performed concurrently, so they are discussed here under a single heading.

During the first phase of instructor supervision, you guide the student through the various components required to perform the skill through the use of patter and follow-me-through. Immediately thereafter you should give the student an opportunity to perform the skill, coaching as necessary.

The second phase of student performance requires the student to practise in order to learn the skills. Therefore, adequate time must be allocated for this student activity. During this phase, feedback should be gradually reduced and finally eliminated[40].

Where the demonstration-performance method is used in group instruction (weight-and- balance computations, or use of the navigation computer, for example), before terminating the performance phase, opportunity should be given for the operation to be completed at least once independently, with supervision on an as-needed basis.

Evaluation

In this phase you judge student performance. The student displays whatever competence has been attained, and you discover how well the skill has been learned. From this measurement you determine the effectiveness of the instruction provided.

To measure each student's ability to perform, you require the students to work independently. Therefore, throughout this phase, you must not ride the controls nor offer verbal or body language cues. Any comment as to how well any individual performed the skill must be in relation to the stated objective for the lesson, not necessarily on perfection of the skill or flight test parameters.

Programmed instruction

Programmed instruction is a method of developing self-instructional materials in textbook form or for computers[12].

As student's progress through programmed instructional material, they make a response to each increment of instruction. The material offers them immediate feedback by informing them of the correctness of their responses. The successful completion of each of these increments takes the student one step closer to the intended learning outcome.

The major characteristics of programmed instruction are:

- A clear statement of what the student will be able to do after training
- Careful sequencing of material
- Presentation of material in steps which challenge students but do not exceed their ability
- Active student responses

- Immediate confirmation of answers
- Test and revision of material until the desired learning outcome is achieved.

This approach carries students, step by step, to the learning objectives. In this respect, programmed instruction is generally more tutorial than typical classroom instruction. It gives the student not only what they are to learn, but also guides them in how they are to learn.

Types of programmed instruction

Programmed instruction may be branched or linear.

Branched

Typically, branched instruction gives more information than linear and then requires an answer to be chosen from the multiple-choice type. Each answer has a reference page to turn to. If the correct answer is chosen, new material will be presented. If an incorrect answer is chosen, remedial material will explain where the student went wrong.

For an example of this type of instruction, read *Preparing Instructional Objectives*[26] by RF Mager. This type of programmed instruction is well suited to use with computers[41].

Linear

In linear programmed instruction, the material is itemised and presented in very small steps. A student is prompted so that invariably the correct response is given. Materials are carefully designed to offer as much review as needed to assure the degree of retention appropriate to the subject matter, the learning situation and the needs of the student[42].

The student responds by writing words into spaces provided for that purpose. Linear programming may also be designed to elicit other types of responses. Answers may be given mentally or orally and simple tasks may be performed. Sequences of more complicated tasks that make up a complete procedure may be required.

After completing the response, the student immediately confirms the correctness of the response by comparing it to the programme answer before continuing. Thus, the student progresses smoothly, with a continuous awareness of being correct giving a sense of satisfaction. If the programme is properly constructed, the student will, at a comfortable rate and almost effortlessly, learn the material presented[43].

Proponents of this system[14] attribute its success to the reinforcement it provides and the repetition it uses. If a student encounters the same fact, idea or concept in a number of ways, and if reinforcement or reward occurs each time a correct answer is made, learning takes place.

Each block of new subject matter contains obvious cues to the correct response. Thus, a student finds it virtually impossible to make errors. As a student approaches the learning objective, cues are gradually withdrawn until the student supplies complete answers without being cued.

For an example of linear type programmed instruction, see the **Climbing and descending briefing** – the presentation of the forces acting on the aircraft in a climb. To the casual observer, this sequence may seem unduly simple. To the student who is totally unfamiliar with the subject matter, however, it offers a sort of learning game.

Evaluation

Evaluation is an integral part of the learning process. Whenever learning takes place, the result is a change in behaviour. Evaluation is concerned with defining, observing and measuring the new behaviour. Once instruction has begun, some sort of evaluation is essential to determine both what and how well the student is learning, as well as how effective the course of instruction has been[45]. Evaluation for these purposes may be formative, ie, it is used during a course of instruction, or summative, when it is used at the completion of a course of instruction[46].

Your evaluation may consist simply of observations of the student's performance, or it may be accomplished by more comprehensive, systematic and objective means, by oral questioning, administering written tests, or performance testing[47].

Observations

Flight instructors have a moral obligation to provide guidance and restraint with respect to the operations of their students. This applies to instructor's observations of unsafe or inept operations by pilots who are not aware they are being observed, as well as pilots who have requested an instructor's evaluation or guidance. In the case of an observed unsatisfactory performance, it is your responsibility to try to correct it by the most reasonable and effective means. If unable to correct the situation by personal contact and good advice, you should report the matter to their supervisor.

Recording observations

Subjective written records of observed student performances are known as anecdotal records. Generally, a system is used to record student behaviour that cannot be evaluated by other means, for example, respect for laws, reaction to authority, persistence or physical skill. The main advantage of these records is that they depict behaviour in natural situations. For example, a student may show good knowledge of VFR minima but violate them in everyday situations. These records often form the basis of a written debrief, and they can be of considerable help to the instructor who is to fly with a previously unknown student.

You should record sufficient information about the situations to make the behaviour understood, for example, “entered cloud while concentrating on instruments in the turn”. Just enough detail should be included to make the description meaningful and accurate. The description should be as objective as possible and it should record positive as well as onstructive occurrences.

A more structured form of anecdotal record is the rating scale. Rating scales provide a systematic procedure for reporting your observations. Its value depends on careful preparation and appropriate use. For example, it should measure the desired learning outcome, and it should be used when sufficient opportunity exists to make the necessary observations.

A rating scale, as used in the CAA Flight Test Standard Guides (FTSG), in the measurement of Managing Critical Incidents is given below as an example.

Figure 1

Excerpt from a Flight Test Standards Guide

Aircraft Performance and Operating Requirements

Rating — **70** — **85** — **100**

Not yet competent	COMPETENT	Ideal
(1) Uses inappropriate performance charts, tables or data	(1) Uses appropriate performance charts, tables and data	(1) Uses all appropriate performance charts, tables and data
(2) Uses inappropriate conditions for the calculation of take-off or landing distance, such that safety would be compromised	(2) Uses the appropriate conditions to calculate the take-off and landing distance for a private operation	(2) Uses the appropriate conditions to accurately and quickly calculate the take-off and landing distance for a private operation
(3) Cannot complete the calculations required in (1) and (2) within one hour	(3) Completes the calculations required in (1) and (2) within one hour	(3) Completes the calculations required in (1) and (2) within 30 minutes
(4) Fails to ensure sufficient runway length is available for take-off or landing	(4) Ensures sufficient runway length is available for take-off and landing through local knowledge	(4) Ensures sufficient runway length is available for take-off and landing by correctly comparing distance required to distance available
(5) Is unable to explain or apply the group rating system	(5) Explains the use of the group rating system	(5) Explains the use of the group rating system and applies its principles (as applicable) in flight
(6) Demonstrates inadequate knowledge of factors affecting aircraft performance in winter (ice) or summer (density altitude)	(6) Demonstrates a satisfactory knowledge of seasonal factors affecting aircraft performance	(6) Demonstrates a thorough knowledge of all seasonal factors affecting aircraft performance

Oral questioning

Oral questioning has a wide range of uses in flight instruction. Questions that require the recall from memory of a fact usually start with who, what, when or where. Questions that require the student to combine knowledge of facts with the ability to analyse a situation, solve problems or arrive at conclusions usually start with why or how. Your instructional techniques course will provide guidance on ensuring that questions be asked at all levels of *Bloom’s taxonomy* as is appropriate to the lesson.

Your use of oral questioning can have a number of desirable results:

- It reveals the effectiveness of your instruction.
- It checks the student’s retention of what has been learned.
- It reviews material already covered by the student.
- It can be used to retain the student’s interest and stimulate thinking.
- It can be used to emphasise important points.
- It checks student comprehension.
- It may identify points that need more emphasis.
- It promotes active student participation, which is essential to learning.

Characteristics of effective questions

Preparation

Effective oral questioning requires preparation. You, therefore, should write pertinent questions in advance. The recommended method is to place them in the lesson plan. These prepared questions serve as a framework and, as the lesson progresses, should be supplemented by any impromptu questions you consider appropriate. To be effective, these questions must be adapted to the past experience and present ability level of the student.

One idea

Effective questions centre on only one idea. One idea – one question. A single question should be limited to using who, what, when, where, how or why – not a combination.

Brief

An effective question should be brief and concise. Enough concrete words must be used to establish the conditions or situation exactly, so that instructor and student have similar mental pictures. The student's response should be determined by their knowledge of the subject – not by their ability to understand the question.

Relevant

To be effective, questions must apply to the subject of instruction[48]. Unless the question pertains strictly to the particular training being conducted, it serves only to confuse the student and divert their thoughts to an unrelated subject. Any part of a question that the student could disregard and still respond correctly should probably be removed.

Only one answer

Usually an effective question has only one correct answer, although in a problem solving question it may be expressed in a variety of ways.

Challenging

Effective questions present a challenge to the student. Questions of suitable difficulty serve to stimulate learning. The difficulty of the question should be appropriate to the student's level of training.

Questions to avoid

Asking "Do you understand?" or "Have you any questions?" have no place in effective questioning. Assurance by the student that they do understand, or that they have no questions, provides no evidence of their comprehension.

Catch-em-out questions should be avoided, as the student will soon develop the feeling that they are engaged in a battle of wits with you. Other types of questions to avoid are:

The puzzle

"What is the first action you should take if a conventional gear aircraft with a weak right brake is swerving left in a right crosswind during a full-flap power-on wheel-landing?"

The oversize

"What do you do before starting the engine?"

The toss-up

"In an emergency, should the crew activate the escape slide or control the passengers?"

Bewilderment

"In reading the altimeter – you know you set a sensitive altimeter for the nearest station pressure – if you take temperature into account, as when flying from a cold air mass through a warm front, what precaution should you take when in a mountainous area?"

Irrelevant

The teaching process is an orderly procedure of building one block of learning on another, and the introduction of unrelated facts and thoughts will only obscure this process and retard the student's progress.

Answering a student's questions

The answering of a student's questions must conform to certain considerations if it is to be an effective teaching method.

The question must be clearly understood by you before an answer is attempted. You should display interest in the student's question and frame an answer as direct and accurate as possible. For example, if the student asks "What is drag?"

an appropriate answer would be, “Drag is the resistance experienced by a body in motion through a fluid”.

After you complete a response, it should be determined whether or not the student is completely satisfied with the answer. In the example given, this may lead to a discussion on the factors that affect drag. Organising the answers in this way conforms with the recommended teaching method for the development of a subject, in this case from simple to complex.

Sometimes it may be unwise to introduce the more complicated or advanced considerations necessary to completely answer a student’s question, for example, the drag formula. In this case, you should carefully explain to the student that the question was good and pertinent but that the answer would, at this time, unnecessarily complicate the learning task at hand. This is particularly true of the pre-flight brief where time does not permit irrelevant or in-depth discussions. If it will not be answered later in the normal course of instruction, you should advise the student to ask the question again later.

On rare occasions, a student asks a question which you cannot answer; you should freely admit not knowing the answer, but should get the answer. If practicable, you could help the student look it up in available references.

Instructors should avoid using the one-word answers “Yes” or “No” if the greatest instructional benefit is to be gained from the student’s question.

Written tests

As evaluation devices, written tests are only as good as the knowledge and proficiency of the test writer. The following are some of the basic concepts of written test design.

Many publications are available on test administration, test scoring and test analysis, so these topics are not covered in this chapter[47].

Characteristics of a good written test

If a test is to be effective, it must have certain characteristics; the most important of these are validity, reliability and useability[47].

Validity

Validity is the most important feature of any written test; it is the ability of a test to measure what it is supposed to measure. The results of a written test are said to be valid only when they are interpreted in relation to what the test was supposed to measure. For example, if instruction has centred on the term stalling angle, and the test question refers to the critical angle, the test result would be invalid in relation to the stalling angle, but it may have validity if interpreted in relation to a broader knowledge of stalling.

Reliability

Reliability refers to the consistency of results obtained from a test or any other measuring device. A metal rule that expands and contracts with temperature changes will not give reliable results. By the same token using a device that is highly reliable does not necessarily mean the results will be valid. For example, an altimeter incorrectly calibrated will consistently measure altitude above the wrong datum; the result is reliable, but wrong (not valid).

Useability

Useability is a measure of the test’s practicality irrespective of other qualities. Tests should be easily administered and scored, produce results that can be accurately interpreted, and be economical in time and cost.

Written test questions

In flight instruction the essay-type question is rarely used and will not be discussed here. Those most commonly used are:

- The short-answer type, which for the purposes of this discussion includes the true/false type.
- The multiple-choice type, which for the purposes of this discussion includes the matching type.

Short-answer type

The short-answer question requires the student to supply their own answer. The shortest possible answer will be in response to the true/false question, and the longest answer extending to perhaps half a page. Other than the true/false type, these questions can be difficult to mark. For example, in the simplest one-word answer type, “The aircraft stalls at the _____ angle” the answer could be stalling, critical or same, and you are sure to get someone who answers with 15-degree.

The correctness of the answer is subjective (decreasing reliability as well as validity depending on how the answer is interpreted). Therefore, the same test graded by different instructors may result in different scores. The more latitude the student has in the answer the more difficult it becomes to assess their answer. While the true/false question eliminates this problem, it also provides the highest probability of guessing the answer. For these reasons the multiple-choice or matching type question is generally favoured.

Multiple-choice type

When properly devised and constructed, the multiple-choice type offers several unique advantages that make it more widely used and versatile than either the matching or true/false question.

Multiple-choice questions are highly objective; that is, the results of such a test would be graded the same regardless of the student taking the test or the person marking it (reliability). This makes it possible to directly compare the performance of students within the same class or in different classes, students under one instructor with those under another, and student accomplishment at one stage of instruction with that at later stages (validity). This type of test question permits easy marking and allows you to examine more areas of knowledge, over the same period, than could be done by requiring the student to supply written responses (useability).

Three major difficulties are encountered in the construction of multiple-choice test questions:

- development of a question stem which can be expressed clearly and without ambiguity;
- an answer which cannot be refuted; and
- the invention of distracters which will be attractive to those students who do not possess the knowledge or understanding necessary to recognise the correct answer.

The stem

The stem may take several forms:

- it may be a direct question followed by several possible answers;
- it may be an incomplete sentence followed by several possible completions to the sentence; or
- it may refer to a graph or diagram followed by several correct or incorrect statements about the graph or diagram.

The student may be asked to select the one choice that is the correct answer, the one choice that is the incorrect answer, or the one choice that is the most correct answer.

These three methods of answering, combined with the three question forms, give you flexibility in preparing multiple-choice questions. However, experience has shown that the direct question form is the most successful for instructors inexperienced in the writing of multiple-choice questions.

Examples:

Stem presented as a direct question

This form is generally better than the incomplete stem in that it is simpler and more natural.

> Which gas forms the largest part of the atmosphere?
>
> a. oxygen
>
> b. nitrogen
>
> c. helium
>
> d. hydrogen
>
> e. neon

Stem as an incomplete statement

When using this form, care must be taken to avoid ambiguity, giving clues and using unnecessarily complex or unrelated alternatives.

> The atmosphere is a mixture of gases, the largest part being:
>
> a. oxygen
>
> b. nitrogen
>
> c. helium
>
> d. hydrogen
>
> e. neon

Stem supplemented by a diagram

Useful for measuring ability to read instruments or identify objects.

> Name and label the four forces acting on the aircraft in straight-and-level flight.

"None of the above" or "all of the above" as alternatives

These are very poor alternatives and should not be used. This is why no example is given here.

The negative variety

These should be avoided as the negative raises the difficulty of the question. If they must be used, the negative should be emphasised.

Which of the following is **NOT** used to control an aeroplane in flight?

a. elevator

b. aileron

c. throttle

d. cyclic

e. rudder

Association type

This type is useful if a limited number of associations are to be made. Matching questions serve better if a large number of related associations are to be made.

Which manoeuvre does **NOT** belong with the others?

a. chandelle

b. autorotation

c. lazy eight

d. loop

e. steep turn

Definition type

These are useful for determining knowledge of basic rules or facts.

The difference between magnetic north and true north is known as:

a. turning error

b. variation

c. deviation

d. compass error

e. dip

When multiple-choice questions are used, four or five alternatives are generally provided. It is usually difficult to construct more than five plausible responses. If there are less than four alternatives, the probability of guessing the correct response is considerably increased. Recent studies suggest three responses carefully constructed are sufficient to determine knowledge.

Principles of multiple-choice type question construction

Make each question independent of every other question in the test. The wording of a question in the test should not provide the correct answer to any other question. For example, avoid pairs of questions like this: Q1. If an aircraft has a rate of climb of 500 feet per minute, what amount of altitude will be gained in one minute? Q2. Define Rate of Climb. Another bad practice is to have the answer to any question dependent on knowing the correct answer to any other question. For example, this is bad: Q1. If an aircraft weighs 1600 lb, how much lift will be required for straight-and-level flight? Q2. If the lift/drag ratio is 10:1 how much drag is produced in Q1?

Design questions that call for essential knowledge rather than abstract background knowledge or unimportant facts.

State the question in the working language of the student. A common criticism of written tests is the emphasis on the reading ability of the student. If language comprehension is not the objective of the test, failing to use appropriate language will decrease validity.

Include sketches, diagrams or pictures when they can present a situation more vividly than words. They add interest and avoid reading difficulties with technical language.

Avoid the negative word or phrase. A student who is pressed for time may identify the wrong response simply because the negative form was overlooked.

Double negatives should be avoided because invariably they cause confusion. If a word such as “not” or “false” appears in the stem, avoid using another negative in the alternatives.

Catch questions, unimportant details and leading questions should be avoided as they do not contribute to effective evaluation. Moreover, they tend to antagonise the student.

Research the question stems and appropriate verbs to use to frame questions at the varying levels of Bloom’s Taxonomy.

Principles of stem construction

The stem should clearly present the problem or idea. The function of the stem is to set the stage for the alternatives that follow.

The stem should be worded in such a way that it does not give away the correct response.

Put everything that pertains to all alternatives in the stem. This helps to avoid repetitious alternatives.

Generally avoid using "a" or "an" at the end of the stem. These may give away the correct choice. Every alternative should fit grammatically with the stem.

Principles of alternatives construction

Incorrectness should not be the only criterion for the distracting alternatives. A common misconception or a statement that is itself true, but does not satisfy the requirements of the problem, may also be used.

Keep all alternatives of approximately equal length.

When alternatives consist of numbers they should be listed in ascending order.

Matching type

The matching type question is particularly good for measuring the student's ability to recognise relationships. As this question type is a collection of multiple-choice questions it samples more student abilities in a given period of time. Samples of two different forms of this type follow.

Equal columns: When using this form, always provide for some questions in the response column to be used more than once, or not at all, to preclude guessing by elimination. For example:

a. Never exceed speed	1. Va
b. Best angle of climb speed	2. Vno
c. Red radial line on the airspeed indicator	3. Vx
d. Design manoeuvring speed	4. Vne
e. Best rate of climb speed	5. Vy

Unequal columns: Generally these are preferable to equal columns.

a. Never exceed speed	1. Va
b. Best angle of climb speed	2. Vno
c. Red radial line on the airspeed indicator	3. Vx
d. Design manoeuvring speed	4. Vfe
e. Best rate of climb speed	5. Vne
	6. Vy

Principles of matching-type question construction

Unlike the examples above, give specific and complete instructions. Do not make the student guess what is required.

Also unlike the questions above, test only essential information.

Use closely related material throughout the question.

Where possible, make all responses plausible.

Use the working language of the student.

Arrange the alternatives in a sensible, easily read order.

If alternatives are not to be used more than once, provide extra alternatives to avoid guessing by elimination.

Effective question writing

Question writing is one of your most difficult tasks. Besides requiring considerable time and effort, the task demands a mastery of the subject, an ability to write clearly, and an ability to visualise realistic situations for developing relevant questions. Because of the time and effort required in the writing of effective questions, it is desirable to establish a question bank or pool.

As long as precautions are taken to safeguard the questions in a pool, the burden of continually preparing new questions will be lightened (but not eliminated). The most convenient and secure method is to record questions on a computer. These can be added to or amended as required, and using the cut and paste feature, different examination papers can quickly be compiled and printed.

Principles of effective question writing

Regardless of the question type or form, the following principles should be followed in writing or reviewing questions[49].

Each question should test a concept or idea that it is important for the student to know, understand or be able to apply.

The question must be stated so that everyone who is competent in the subject would agree on the correct response.

The question should be stated in the student's working language.

The wording should be simple, direct and free of ambiguity.

Sketches, diagrams or pictures should be included if they add realism or aid the student in visualising the problem.

The question should present a problem that demands knowledge of the subject. A question that can be responded to on the basis of general knowledge does not test achievement.

Performance tests

If a student demonstrates the ability to perform selected parts of a skill for which they are being trained, it is assumed that they will be able to perform the entire skill. Performance testing is a sampling process. It should be a carefully selected part of an action process typical of the skill for which training is being given. For example, successful completion of a cross-country flight test would assume the student is able to fly anywhere in New Zealand.

This method of evaluation is particularly suited to the measurement of student abilities in either mental or physical tasks. Performance testing is desirable for evaluating training that involves an operation, a procedure or a process, and it is used extensively in flight instruction.

Evaluation of demonstrated ability during flight instruction must be based upon established standards of performance (see the appropriate FTSG), suitably modified to apply to the student's experience, stage of development as a pilot and the conditions under which the demonstration was performed. For the evaluation to be meaningful to you, the student's mastery of the elements involved in the manoeuvre must be considered, rather than merely the overall performance.

In evaluating student demonstrations of piloting ability, as in questioning and other instructional processes, it is important to keep the student informed of progress. This may be done as each procedure or manoeuvre is completed or during the debriefing.

Instructional aids

An instructional aid is any device that assists an instructor in the student's learning process. They may be sight or sound devices, or a combination of both. Instructors use them to improve communication between themselves and their students, but the aids do not substitute for instruction[50]; they are used to support, supplement or reinforce teaching.

Reasons for using them

Gaining and holding student attention is essential to learning. Visual aids which support the topic with some degree of novelty draw attention to the information and cause both the seeing and hearing channels of the mind to process the same or similar information[51].

An important goal of all instruction is for the student to retain as much of the instruction as possible and a significant improvement in student retention occurs when instruction is supported with meaningful aids[52].

It is difficult for instructors to use words that have the same meaning for the student as they do for you. For example, try describing level attitude, using words only, to a student that has not flown before. The good instructor makes learning easier and more accurate for the student by providing visual images[53].

It is often difficult for a student to understand relationships, for example, CL to Angle of Attack. If the relationships are presented visually, they are much easier to deal with. Symbols, graphs and diagrams can show relationships of location, size, time, frequency or value[54].

Instructors are frequently asked to teach more and more in less and less time. Instructional aids can help them do this.

Guidelines for their use

The decision to use any instructional aid should be based on its ability to support a specific point in a lesson[55].

Aids should be simple and compatible with the learning outcomes to be achieved. Since aids are used in conjunction with a verbal presentation, words on the aid should be kept to a minimum and distracting artwork avoided[56]. You should avoid the temptation of using the aid as a crutch. For example, the introduction of PowerPoint saw many instructors fall into this trap, believing that a slide or series of slides, with everything on them, could substitute for the lesson or briefing. A six-by-six rule of thumb can be applied to the preparation of slides – 6 words across and 6 lines down, **maximum**.

Aids have no value in the learning process if they cannot be heard or seen. Recordings of sounds and speeches should be tested for adequate volume and quality. Visual aids must be visible to the entire class, with lettering large enough to be seen by the students farthest from the aid. Colours, when used, should contrast and be easily visible. The surest and most successful rule is, before the student arrives, test visual and aural aids in the environment in which they will be used.

The effectiveness of aids can be improved by proper sequencing[57]. Sequencing can be emphasised and made clearer by the use of contrasting colours.

The effectiveness of aids and the ease of preparation can be increased by planning them in rough draft form. The rough draft should be carefully checked for accuracy, clarity and simplicity. Revisions and alterations to a draft are easier to make than changes to a final product.

The purpose of all instructional aids is to improve the student's understanding so care must be taken to present information from the student's perspective. For example, when using an attitude window, point out what the attitude looks like from the student's (left-seat) perspective.

Types

Some of the most common aids are whiteboards, models, illustrations, handouts, projected materials and computers.

Whiteboard or blackboard

The whiteboard is one of the most widely used aids to learning. Its versatility and effectiveness make it a valuable aid to most types of instruction. The following practices are fundamental in the use of a whiteboard or blackboard:

- Keep the board clean.
- Erase all irrelevant material.
- Keep chalk or pens, erasers, rulers and other equipment readily available to avoid interruption of the presentation.
- Organise the board and practise the presentation in advance.
- Write or draw large enough for everyone in the group to see.
- Do not overcrowd. Leave a margin around the material and space between lines.
- Present material simply and briefly.
- Use lower case for presentation of material to be learned as the easier interpretation facilitates learning and leave upper case for titles.
- If necessary, use the ruler or other devices in making drawings.
- Use colour for emphasis.
- Stand to the side of the material being presented, so that the entire class will have an unobstructed view.
- Do not talk to the board – when speaking, face the student or group; when writing, write!

Models

A model is a realistic copy or simulation of a real piece of equipment. Models are not necessarily the same size as the equipment they represent, nor are they necessarily workable. However, a model is generally more effective if it works like the original. With the display of an operating model, the students can observe how each part works in relation to the other parts, ailerons for example. As instructional aids, models are usually more practical than originals because they are lightweight and easily moved.

The most commonly used model in flight instruction is that of an aircraft. In accordance with the above general principles the model aircraft should at least bear some resemblance to the aircraft being used for training, high- or low-wing for example.

You should always hold the model aircraft by the nose, so that the tail of the aircraft points toward the student. This gives the student the perspective of sitting in the pilot's seat. For example, which aileron goes down and which goes up in the turn is your problem to solve not the student's.

Illustrations

Material should be displayed in a clear, easily understood format. Safety posters are a good example. A large photograph of the aircraft instrument panel is particularly useful. However, as with any other model representation, it is of little value – even detrimental –

if it does not represent the aircraft in use. An extreme example would be using a photograph of an A320 instrument layout for a pilot training in a Cessna.

Handouts

Handouts comprise any written material distributed in relation to the lesson. They can include copies of your notes, illustrations, articles or overhead projection material. They may be distributed during, or at the completion of the lesson, depending on your preference.

For the pre-flight briefing, handouts are best utilised in a systematic manner, linking the exercises being taught.

For example, at the completion of the straight-and-level lesson the student is given a handout on climbing. This first asks relevant questions in regard to the practical aspects of straight-and-level. Revision questions relating to earlier instruction could also be included. Then the handout covers the theory and considerations of climbing in depth. This is in more detail than would be covered in the pre-flight brief including, for example, any relevant checklists or radio procedures. The handout ends with relevant questions on the climbing text.

You now present the pre-flight briefing on climbing, and the exercise is flown and de-briefed. Then a handout on descending is given to the student, on the first page of which are questions relating to climbing air exercise – and the cycle is repeated.

The use of handouts in this manner provides a continuous cycle of repetition, recency and arousal.

Projected material

Projected material includes motion pictures, video, slides, and PowerPoint. The essential factor governing their use, as with all instructional aids, is that the content supports the lesson.

Video appeals to students, while packaged lessons appeal to instructors; care should be exercised to ensure that the lesson is being supported – not supplanted.

Video should be previewed and summarised by you before use.

Films and video are good for gaining and maintaining attention, but they do not lend themselves well to the interactive learning process. Slides combined with your presentation provide greater opportunity for interaction.

Use of projected materials requires careful planning and rehearsal by you to adjust equipment, lighting and timing.

Computer-based instruction

At this time, the computer is by far the most versatile kind of aid available to instruction[58].

Computers combine the features of film or audio in gaining and maintaining attention and can provide simulation and interactive feedback. With the development of touch-screen technology, exciting possibilities for interactive instruction and feedback have become possible[59].

At first glance, the computer appears to incorporate all the considerations of effective instruction. However, the computer still lacks the ability to provide for an individual's social and egoistic needs. For example, belonging, appreciation and recognition. For this reason it is worth stating again that instructional aids are used in support of your delivery; they should not substitute for instruction itself.

Future developments

Recent years have seen an explosion of new materials and techniques in the field of instructional aids. The effective instructor strives to keep abreast of new devices, new materials, and their potential uses. In choosing an appropriate instructional aid, you must be receptive to new possibilities and keep in mind the learning goal to be achieved, as well as the role of the instructor in human relations[60].

Role modelling

The influence of a flight instructor is so great that it merits a career path and status of its own[14]. In this chapter we discuss the influence of your behaviour on that of your students.

Professionalism

Professionalism in flight instruction demands a code of ethics that is in no way related to the monetary gains. Flight instructors must strive for the highest levels of professionalism as attempts to operate otherwise as a flight instructor can result only in poor performance and deficient students. Anything less than a sincere effort will quickly be detected by the student, destroying your effectiveness.

Professionalism also includes a flight instructor's public image. In the past, flight instructors have all too often been willing to accept a less than professional status in the public view by relaxing their demeanour, appearance and approach to their profession.

If the status of the flight instructor in the general aviation industry is to be upgraded, it must be done through the efforts of flight instructors themselves.

The professional flight instructor commands the respect of associates and, most importantly, delivers more effective instruction.

Sincerity

The student pilot accepts the flight instructor as a competent qualified teacher and expert pilot. Attempting to hide inadequacy behind a smoke screen of unrelated instruction will make it impossible to command the respect and attention of the student; the professional flight instructor should be straightforward and honest.

In addition, instruction that emphasises safety will be negated if you appear to ignore your own instruction, eg, taxiing quickly, or descending below minimum altitudes.

The same applies to your insistence on precision, accuracy and smoothness of handling. The professional instructor is constantly under scrutiny and is expected to excel in aircraft handling.

Personal appearance and habits

Personal appearance has an important effect on the professional image of the instructor. Today's aviation customers are people who expect their associates to be neat, clean and appropriately dressed. It is not intended that the flight instructor should assume attire foreign to the flight environment, but as you are engaged in a learning situation, often with professional people, the attire worn should be appropriate to a professional status.

Personal habits have a significant effect on the professional image. The exercise of common courtesy is perhaps the most important of these. A flight instructor who is rude, thoughtless, impatient or inattentive cannot hold the respect of the students, regardless of piloting ability. Young, confident flight instructors need to give careful consideration to these points when dealing with students older than themselves.

The professional instructor maintains a genuine interest in the student's learning. Under no circumstances should you do or say anything that is derogatory to the student. Acceptance rather than ridicule, and support rather than reproof will encourage learning, regardless of whether the student is quick to learn or is slow and apprehensive. Criticising the student for not learning is not unlike a doctor criticising a patient for not getting well, and is totally unacceptable from a professional.

The professional image requires a calm, thoughtful and disciplined demeanour. Frequently countermanding directions, reacting differently to identical errors, and demanding unreasonable performance or progress should be avoided.

On rare occasions a personality conflict may arise between instructor and student. If, for any reason you suspect this, you should discuss the problem with your supervisor who has the experience to confirm your suspicions or offer alternative teaching methods to overcome conflict.

Cleanliness of body and breath is important to flight instruction. The cabin is a close, tightly sealed area, where an instructor and student work in close proximity and where little annoyances provide serious distractions from the learning task. Likewise, the flight instructor should not be subjected to body odour from the student. If the role model example set by you is not perceived by the student, some honest discussion may be required. Once again, it is best to discuss the resolution of this problem with your supervisor.

Safety and accident prevention

The flying habits of the flight instructor, both during instruction and as observed by students, have a direct effect on safety. Students consider their flight instructor to be a paragon of flying proficiency whose flying habits they, consciously or unconsciously, attempt to imitate. For this reason, a flight instructor must meticulously observe the safety practices taught to the students, such as using full runway length for take-off.

A flight instructor must carefully observe all regulations if a professional image is to be maintained. An instructor, who is observed to fly with apparent disregard for loading limitations, weather minima, or runway length creates an image of irresponsibility that many hours of conscientious flight instruction cannot correct.

Self improvement

"The input of aviation instruction is for as long as a pilot flies."[14] Professional flight instructors must never become complacent or satisfied with their own qualifications and ability. They should be constantly active and alert for ways to improve their qualifications, teaching effectiveness and the service they provide to students. Flight instructors are considered authorities on aeronautical matters and are the experts to whom many pilots refer questions concerning regulations, requirements and operating techniques.

It is essential that you maintain access to current copies of Civil Aviation Rules, their associated Advisory Circulars, and Flight Test Standards Guides, including Flight Training Standards guides. A flight instructor who is not completely familiar with current pilot issue and rating requirements cannot do a competent job of flight instruction. However, you are not alone; if confronted with a question to which you do not know the answer, turn to your supervisor.

Better, make use of your supervisor to get answers before the questions arise. Your supervisor (probably your role model) is there to assist you – and has certified your logbook to this effect.

There are many means of self-improvement available to flight instructors: the CAA website; CAA Vector magazine; Good Aviation Practice (GAP) booklets; DVDs; aviation periodicals; recognised texts; seminars and papers offered by the CAA; Massey, Auckland, Wellington and Otago Universities; instructional techniques and advanced instructional techniques courses, as well as libraries and other websites are all valuable sources of information for flight instructors.

Although the recommended reference texts are expensive, a reference library is as essential to the professional instructor as a navigation computer is essential to the professional pilot.

Flight instructors have a tremendous influence on their student's perception of aviation in general and piloting in particular. The level of professionalism shown by flight instructors in the way they conduct themselves and the attitudes they display directly affect their student's flying.

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Briefings

Briefings introduction

The sample preflight briefings given here are adequate for the purpose of the Category C Flight Instructor issue flight test.

The novice instructor must realise that there is no standard briefing because there is no standard student.

These preflight briefings then, are a guide to the novice instructor, and their content and breadth should not be considered comprehensive. For example, no briefing on the use of the aircraft radio is given here, but this does not mean that none is required. In addition, these briefings are very generalised, and some modification will be required to meet the operating requirements of specific aircraft types.

Detailed information and some formulae have been included in the academic considerations of each briefing. These are only included to give the novice instructor a broad appreciation of the reasons behind the contents of the airborne sequence. They are not meant to be written out in full, nor necessarily discussed during the preflight briefing. In addition, suggested briefing introductions, comments or even the suggested briefing layouts are not required to be delivered verbatim.

How much detail, background information or theory is added, and which parts are deferred or arranged differently, is the responsibility of the qualified instructor.

The specific ability to modify the preflight briefings with regard to the student's previous experience, the conditions on the day, and the objectives, is what is usually examined during the upgrade flight test from Category C to Category B Flight Instructor.

Under Category C issue flight test conditions, it is common practice, and acceptable, for the preflight briefing to take up to one hour to deliver.

The sequence and contents of the briefings presented here follow a generally accepted pattern. However, the Chief Flying Instructor (CFI) of each training organisation has final discretion over the sequence and briefing content used within their own organisation.

Throughout this text the words control column, control wheel and stick are used interchangeably, as they all have the same function and sense of movement.

The preflight briefing

Before beginning a preflight brief you need to know the student's past experience in order to give relevance to the lesson. This may be simple enough to achieve if the student is known to you, has completed a post-flight questionnaire relating to their last lesson or has no previous flight experience. Where the student has previous flight experience and is not known to you, research of the student's anecdotal records will be required. Where these are not available, nor is the student's past instructor, the student's logbook forms a valuable, if limited, reference.

Where the student with past flight experience is unknown to the organisation, the CFI generally conducts an evaluation flight to assess the student's goals, values, self-concept and position within the syllabus. The CFI then provides you with the new student's relevant details.

The use of abbreviations during the briefing, for example, A/C for aircraft, is common and acceptable as long as the meaning of the abbreviation is explained.

Each preflight briefing has a title and is discussed under five or six headings.

The title

Typically the title is a very brief statement. Although the title may clearly convey to you what the lesson is about, it may not for the student. As soon as the subject is introduced a verbal explanation of what the lesson is about is given, showing relevance and relating it to past experience.

The introduction sets the scene for what could be either an interesting briefing during which the student is receptive – or a boring, unpleasant experience.

Objective

The lesson objective should state what the student should be able to do at the end of the lesson. In the preflight briefings given here, no performance parameters have been stated. When adding these to the objective, you must consider the student, the aircraft and the conditions on the day, so that the objective is achievable.

As many flight exercises are simulations, it's important to keep in mind the requirements of the lesson objective so that the student is able to achieve the lesson outcome without endangering the aircraft. For example, the objective of the forced landing exercise is not to make a successful landing, because the student must land to achieve that objective.

Likewise, the use of the word safe in the objective should be avoided. Safety and being safe is a concept which is difficult to observe or measure. Promoting safety in general is desirable, and it should be emphasised that all flight operations should be conducted in a manner that enhances safety. However, as safety is not observable or measurable, it is not used in the lesson objective.

Principles of flight or considerations

Under the heading of 'Principles of flight', the basic principles of flight relating to the air exercise are discussed. This means that only simple explanations are used. These should directly support the air exercise. This is not an opportunity for you to discuss everything they know on the subject, nor is it a requirement of the flight test during the briefing (a separate examination of your knowledge is conducted later).

The heading of 'Considerations' is sometimes used where no direct principles of flight relate to the air exercise. It can also be used in the air exercise itself to introduce similar exercises, for example, steep turns and steep gliding turns.

Airmanship

Airmanship has many explanations, depending upon the reference and the context.

Keep the explanation simple for the student to understand and apply. Fundamentally this means lookout considerations and principles, maintaining situational awareness, appropriate decision-making, and threat and error management.

Aircraft management

Aircraft management implies a broader operational context than engine handling. It prepares the student for the operation of more complex aircraft and considers aspects of total flight management.

Information presented here is meant to relate to both the immediate air exercise and the general requirements of the aircraft operation.

There is no requirement to find something to put in here. For example, medium turns does not require smooth throttle movements or mixture rich, so these can be ignored or revised at instructor discretion.

Human factors

Currently some form of human failure causes 70 percent of all aircraft accidents. Information presented here is meant to introduce the student to human limitations that may be observed or experienced during the air exercise, especially those areas that affect decision-making and pilot judgement.

Good aviation practice is broadly defined as common sense in the air. Good aviation practice is incorporated under the 'Human factors' heading because human limitations are known and can be taught, whereas good aviation practice is generally accepted as something you either have or have not. For example, good aviation practice requires a good lookout, whereas human factors describes the limitations of the human visual system and how to overcome those limitations to achieve a good lookout.

The ADVISE model (Altitude, Disorientation, Vision, Information processing, Stress and Esprite or E'alth – health), developed by Ewing (1994), is an aid for considering which aspects of the human factors syllabus should be incorporated into the preflight briefing. For example, altitude, is an aspect of known human limitations directly involved in climbing but not medium turns.

Air exercise

This is the reason for the preflight briefing and everything presented before this point should directly support the air exercise.

Generally the air exercise will follow a sequence of entry, maintain, and exit.

Airborne sequence

Generally, the airborne sequence is:

1. Demonstration
2. Follow me through
3. Instructor talks student through
4. Student practice.

The demonstration is a physical statement of the lesson objective: "Here is what you will be able to do at the end of this lesson".

The follow through is a pattered breakdown, by you, of the actions required to complete the manoeuvre, or part of the manoeuvre.

The instructor talk through is a re-assembly, by the student, of the actions required to complete the manoeuvre with instructor assistance.

Student practice involves evaluation by both instructor and student as to whether or not the student's performance achieves the lesson objective. Remember that perfection or a performance within flight test parameters, is not necessarily a part of the lesson objective.

Student practice should not be continued beyond the point at which the objective is achieved.

Patter

The airborne patter should follow the same sequence as the briefing, using the same words and avoiding the inclusion of material or exercises that were not covered in the briefing. In most air exercises, the movement of the aircraft controls can be slowed down, permitting synchronisation of the patter with aircraft movement. Where this is not possible, for example, with spinning, you must be careful not to include too much verbal detail in one demonstration.

Control inputs

Your flying should be accurate and control movements should be smooth and coordinated at all times. The use of jerky, abrupt or uncoordinated control movements should be avoided wherever possible. For example, when discussing the suitability of a particular field for forced landing practice, the aircraft should be positioned such that both the student and instructor can clearly see the field in a gentle turn and a constant altitude maintained. Poor altitude control, or rolling the aircraft with aileron and keeping straight with rudder, in an attempt to keep the field in sight, resulting in crossed controls, should not be demonstrated.

Aircraft control

You are the pilot-in-command. The safety of the aircraft, crew and passengers is of paramount importance to the pilot-in-command. However, achieving the maximum benefit from the learning experience is of paramount importance to the professional instructor.

The decision to give the student control or to take control yourself can only be based on experience. The professional flight instructor retains situational awareness at all times and never allows the safety of the flight to be compromised.

Generally, when handing over control to the student, make sure the student realises they have full control by removing your hands from the control wheel, column or stick, and throttle as well as removing your feet from the rudder pedals. Follow-me-through exercises are used to give the student insights to control movements and build confidence. However, when handing over control, often removing your feet from the rudder pedals is difficult or overlooked, and this can lead to subconscious control inputs that only undermine the confidence of the student.

In some exercises, maintaining a very light feel on the rudders may be beneficial to your assessment of student performance. Great care must be taken, however, not to lead or override the student's inputs.

Parallax error

Parallax error results from viewing the pilot's instrument panel at an oblique angle. Its effects are most noticeable with regard to balance, aligning the Directional Indicator (DI) and angles of bank on the Artificial Horizon (AH).

As a result of side-by-side seating a similar effect occurs when viewing aircraft attitude and reference points in relation to the aircraft nose. Remember it's what the student sees that is of prime importance.

Airmanship

"The teaching of airmanship is above all a matter of clear example displayed by the instructor."

Continuity

Where convenient (refer CFI) the manoeuvre to be taught in the next lesson is demonstrated at the end of each air exercise.

The debriefing

No skill is more important to an instructor than the ability to analyse and judge student performance. The student quite naturally looks to you for guidance, analysis, appraisal, suggestions for improvement and encouragement.

A debrief may be either oral, written or both, and it may be used in the classroom as well as the aircraft. It should come immediately after a student's performance, while the details are easy to recall.

As with all evaluation, a debrief is not a step in the grading process, it is a step in the learning process. A debrief should not be negative in content; it should consider the good along with constructive feedback on what and how to improve.

A debrief should improve the student's performance and provide them with something constructive to work and build on. It should provide direction and guidance to raise their level of performance.

Characteristics of an effective debriefing

Objectivity

The effective debrief is focused on student performance and should not reflect your personal likes and dislikes. Instructors sometimes permit their judgements to be influenced by their general impressions of the student, favourable or unfavourable, to such a degree that it influences objectivity. If a debriefing is to be objective, it must be honest. It must be based on the performance as it was, not as it could have been or as you and student wish it had been.

Flexibility

You must fit the tone, technique and content of the debriefing to the occasion and the student. Again and again, you are faced with the problem of what to say, what to omit, what to stress, and what to minimise. The debriefing challenges you to determine what to say at the proper moment. The effective debrief is one that is flexible enough to satisfy the requirements of the moment.

Comprehensiveness

A comprehensive debriefing is not necessarily a long one, nor must it treat every aspect of the performance in detail. You must decide whether the greater benefit will come from a discussion of a few major points or a number of minor points. An effective debrief covers strengths as well as weaknesses. How to balance the two is a decision that only you can make. The content should focus on the achievement or not of the objective.

Constructiveness

A debriefing is pointless unless the student profits from it. The student needs to be informed of how to capitalise on things that are done well. Also, it is not enough to identify a fault or weakness, you should give positive guidance for correction.

Organisation

Unless a debrief follows some pattern, a series of otherwise valid comments may lose their impact. The debrief should follow a logical pattern and make sense to the student as well as you. The pattern might be the sequence of the performance itself, or it might begin with the point where a demonstration failed and work backward through the steps that led to the failure. A success can be analysed the same way. Whatever the organisation of the debriefing you should be flexible enough to change it if the student cannot understand it.

Considerate

An effective debrief reflects your consideration of the student's need for self-esteem as well as recognition and approval from others. You should never minimise the dignity and importance of the individual. Ridicule, anger or fun at the expense of the student has no place in a debriefing.

Specific

Your comments and recommendations should be specific, not generalised. A statement such as, "Your second steep turn was better than your first", has little constructive value unless you explain specifically why, how, or in what area the student improved. At the conclusion of the debrief the student should have no doubt what they did well and what they did poorly and, most importantly, specifically how they can improve. If you have a recommendation in mind, it should be expressed with firmness and authority in terms that cannot be misunderstood.

From the above it should be apparent that the ability to conduct an effective debrief is not something that comes naturally. It requires considerable training and practice. Experience has shown that newly qualified flight instructors tend to over-concentrate on performance errors, which are often minor.

The debrief should begin with an opportunity for the student to state how well they thought they did in achieving the objective.

If the objectives were met, you're presented with the opportunity to give immediate positive feedback.

If the objectives were not met, and the student knows why or can explain how they might achieve the objectives in subsequent flights, again the opportunity for positive feedback exists.

The opportunity for the student to speak freely about their performance may provide you with insights about the student that may not otherwise be voiced (their fears or misconceptions).

If the objectives were not met, highlight the main features of the exercise or performance, accentuate the positive, give praise where appropriate, and gradually build on your experience to analyse the student's performance more specifically and constructively.

The Aeronautical Decision-Making (ADM) aspects of the lesson should also be considered in the debrief.

It is highly recommended that you take advantage of the direct supervision period and ensure that your supervisor attends the debriefing. Your supervisor can debrief you, in private, on your performance. Remember, the debrief is not a step in the grading process but a step in the learning process.

Whiteboard layouts

The proposed layouts are again, only a guide. They represent the finished layout and should be supplemented with the use of various aids.

Basic concepts

These first seven lessons are provided in this recommended order.

Please refer to your CFI for the order your organisation uses.

Taxiing

The purpose of this briefing is to consider the effects of the environment on the ground handling of the aeroplane.

These environmental factors include:

- the surface type
- slope
- wind
- wingtip and propeller clearance
- other traffic
- slipstream, jet blast
- seat adjustment
- windscreen cleanliness
- inertia and speed judgement
- blind spots
- aerodrome layout
- instrument checks
- Air Traffic Control (ATC) clearances
- right of way rules, and
- aerodrome signs and markings.

Taxiing is usually introduced during the first lesson, **Effects of controls**, but the considerations are usually spread over the lessons leading up to first solo. It is your responsibility to ensure that the student is aware of these considerations before recommending them for first solo. If a student has limited experience or exposure to operating 'machines', a separate taxi lesson may be appropriate.

Taxiing means: manoeuvring the aeroplane on the ground under its own power. This requires concentration and common sense. Your student needs to understand that an aeroplane is less manoeuvrable than a car, wider because of the wingspan, and you cannot reverse an aeroplane.

Objective

Correctly use the aeroplane's controls to manoeuvre the aircraft on the ground at a speed appropriate for the prevailing conditions and situation, following a selected path and stopping at a nominated point.

Considerations

Speed control

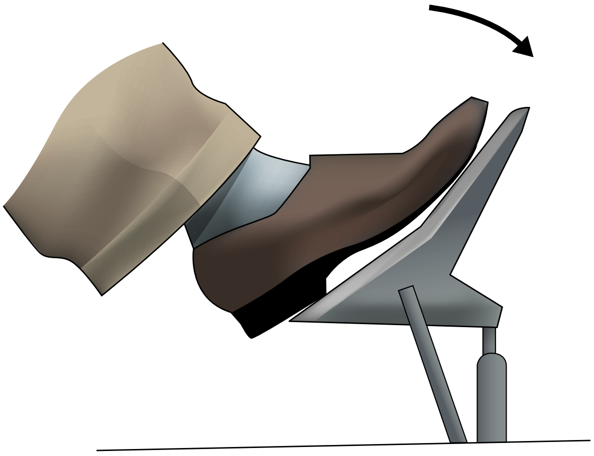
Aeroplane speed is controlled with the hand-operated throttle. Because of inertia, more power will initially be required to get the aeroplane moving. As soon as the desired speed is reached, reduce power as appropriate.

Maintaining taxi speed will be affected by the surface, slope, wind, and power used. Some organisations recommend a minimum power setting while taxiing to minimise spark plug fouling (refer CFI).

To stop, ensure nose wheel is straight, close the throttle fully then apply both main wheel brakes, usually achieved by depressing the tops of both rudder pedals (see Figure 1). Slope, surface (wet or dry), and wind, all affect the ability to stop. How to apply and release the park brake should also be taught.

Figure 1

Braking



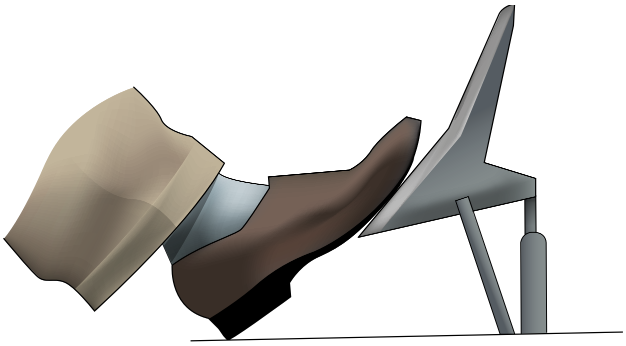
Increase power by moving the lever or plunger forward and decrease power by moving it rearwards.

Directional control

Direction is controlled by nosewheel steering, and is done by pushing the appropriate rudder pedal (see Figure 2). This works in the natural sense – push the left rudder pedal and the nose turns to the left, and vice versa. In some aeroplane types, the rudder pedals may be augmented by differential braking to tighten the radius of turn if required.

Figure 2

Directional control



Wind affects directional control, and crosswinds will cause the aeroplane to weathercock into wind as a result of pressure on the vertical tail fin.

Most problems experienced by the student in maintaining directional control are a result of looking just ahead of the aeroplane, rather than at a point in the distance.

Control positioning

The aeroplane's controls should be held in the appropriate position in relation to wind direction, as stated in the Flight Manual.

The use of full aft elevator in modern nosewheel training aeroplanes is not required while taxiing, but the elevator should be held either in the neutral position or slightly aft to keep the weight off the nosewheel and protect the nosegear. However, this may not be appropriate with high-tail aeroplanes (refer CFI).

Airmanship

Introduce the student to the right-of-way rules, as they apply while taxiing.

Show the student the aerodrome chart from *AIP New Zealand* Vol 4, pointing out the major features of the aerodrome and where to look for them once they are in the aeroplane.

Show the student the location of the windsocks and how to interpret them.

Explain to the student that it is important to communicate with other users of the aerodrome. In order to do this, you will be using radio calls to either the traffic, or the control tower (as appropriate). You will be giving your position, your intentions, and requesting any clearances you may need.

The student should listen to the calls you make and the responses you get. Remember to speak slowly and clearly.

Aeroplane management

Discuss your training aircraft's particular nose wheel characteristics, eg, castoring, etc.

Avoid using power against brake.

The pilot's seating position should be adjusted to make sure they can achieve full rudder deflection, and the seat locking should be checked for security. Make sure the student can reach all of the controls and seat height is adjusted so the student can see over the instrument panel. Introduce the appropriate positions for hands and feet while using the controls.

An appropriate period of engine warming should be observed before taxiing (see the Flight Manual).

Brakes should be checked for normal operation soon after the aeroplane begins to move. Close the throttle, depress the brake pedals with the balls of the feet, then slip the feet back down to the bottom of the rudder pedals.

The correct taxi speed is a fast walking pace, about 5 to 10 km/hr.

The use of carburettor heat on the ground should only be used during the run-up procedure and pre-take-off checks and be on a clear surface, as air from this source is unfiltered.

In winds of more than 5 knots, the aeroplane should always be stopped facing into wind to assist engine cooling.

Taxi on the centreline, but be aware of your own and other aeroplane's wingtips and tailplanes, as well as propeller slipstreams. Be cautious of aeroplanes that may be producing jet blast, and avoid taxiing behind them.

Light aeroplanes may need to taxi right of the centreline to allow opposing direction aeroplanes to pass – aircraft should pass port to port (left to left).

While taxiing, the aeroplane's flight instruments (turn coordination, direction indication, compass, and artificial horizon) should be checked for serviceability.

To prevent propeller damage, avoid taxiing over rough surfaces and limit the use of power when over loose gravel. Keep the aeroplane moving – twice as much power may be required to get going again if the aeroplane stops. If the surface looks doubtful, or excessive power (>2000 RPM) is required; stop, shut down, and get assistance. Do not try to 'power out' of soft ground.

Human factors

Adhering to the right-of-way rules, being familiar with and carrying aerodrome charts, and windsock indications, will help orientate the student.

Vision will be affected by the cleanliness of the windscreen and side windows, and the cabin pillars. Demonstrate the effect of the blind spots that are created by the cabin structure, and wingtip clearance judgement. Show the student how to move the upper body to see around pillars and to mitigate blind spots.

Make sure all flights carry *AIP New Zealand* Vol 4 and appropriate charts to aid the student's information processing.

Ground exercise

The exercise consists of teaching the hand and feet positions and the methods of operating the controls.

Start the aeroplane, apply power to overcome inertia and get the aeroplane moving, test the brakes, maintain an appropriate taxi speed, turn and stop the aeroplane at a designated spot. The student should now practise all these manoeuvres.

Operation of the park brake should be demonstrated and, as appropriate, the effects of slope, surface, wind, and relative positioning to larger aeroplane's slipstreams should also be pointed out.

Introduce aerodrome signs and markings.

Taxiing

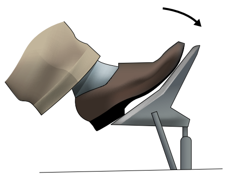
Objective

Use the aircraft controls correctly to manoeuvre the aircraft on the ground at a speed appropriate for the prevailing conditions and situation, following a selected path and stopping at a nominated point.

Considerations

Speed control

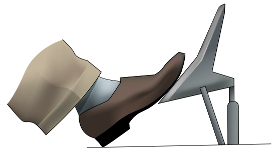
- Throttle controls speed. Forward is more power, and rearwards is less power.
- More power is required to get started and overcome inertia.
- Taxi speed is affected by surface, slope, wind, and power used.
- Should be a fast walking pace – 5 to 10 km/h.
- May need occasional gentle braking to maintain the taxi speed while maintaining the recommended power setting.
- Stop by closing the throttle and using the toe brakes to come to a halt.
- Park brake is set by holding down the toe brakes and engaging the lever.



Braking

Directional control

- Nosewheel steering is achieved by using the rudder pedals. Push on the left rudder and the aeroplane turns left and vice versa. Use differential braking as required to tighten the radius of turn.
- Wind affects the speed across the ground. Tailwind makes you go faster, headwind slower, and crosswind will push the tail and make the aeroplane turn into wind.
- Make sure you look at a point in the distance, not one just ahead of the aeroplane.

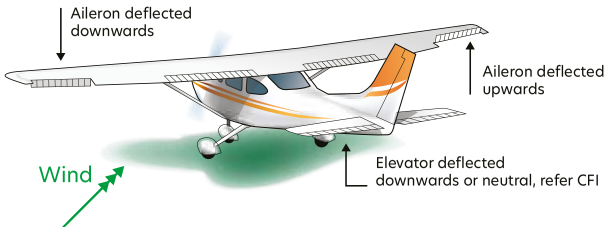


Directional control

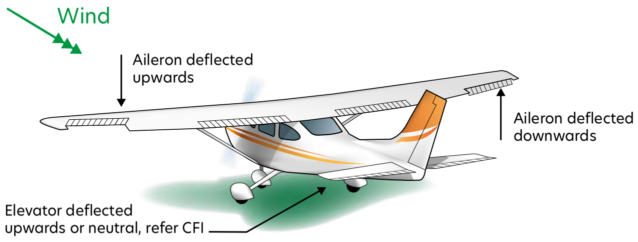
Control positioning

- Complete details are in the Flight Manual.
- Aim to deflect the control surface that will be affected by the wind, so the wind.cannot 'pick it up'.
- Wind from directly behind – control column forward (elevator deflected downwards), ailerons neutral.
- Wind from directly ahead – elevator deflected upwards or neutral, refer CFI.
- Wind from the left – control column left (left aileron raised).
- Wind from the right – control column right (right aileron raised).
- Combination of the above when wind is *quartering*. For example, wind from the left and behind – control column forward and right.

Wind *quartering* from left and behind



Wind *quartering* from left and in front



Ground exercise

- Seat is adjusted and comfortable.
- Once engine is warm, use enough power to overcome inertia.
- Test brakes after moving off.
- Maintain safe taxi speed – fast walking pace.
- Maintain the centreline (if applicable).
- Turn using the rudder pedals to turn the nosewheel.
- Take account of the wind, and the change in the wind as you turn.
- Wingtip clearance can be judged using shadows.
- Caution slipstream and jet blast from other aircraft.
- Slipstream (the air blown back by the propeller) can blow objects and people around behind you.
- During the taxi and while turning, check instruments.
- Stop by applying the toe brakes.
- Apply park brake.

Airmanship

- Check the right of way rules.
- Check the aerodrome chart.
- Check windsock for wind.
- Always carry *AIP* Vol 4 and VNCs.
- Radio communication.

Aeroplane management

- Don't use power versus brakes.
- Seat positioned for full rudder deflection and height.
- Engine warm before moving.
- Brake check soon after first moving.
- Carb heat ON only for checks.
- Face into wind when stopped.
- Taxi on centreline.
- Watch for wingtip clearance.
- No reverse available.
- Caution, surface conditions.

Human factors

- Clean windscreen.
- Move head and body to avoid blind spots.

BASIC CONCEPTS

Effects of controls

This lesson is arguably the most important lesson a student will take. A thorough understanding of the primary and secondary effects of control inputs is the basis of all future flying. It's important that the student understands and has the opportunity to practise these effects.

As this is commonly the first formal preflight briefing, a short explanation of the sub-headings should be included, as well as the normal introduction. The **Airmanship** section covers good aviation practice.

This lesson does not aim to teach the student to fly, that will come over the next few lessons. This lesson focuses primarily on each control, how it works, and how it is related to other controls. As a consequence, some of the manoeuvres in this lesson may seem less coordinated than normal.

Primary flight controls are the elevator, ailerons and rudder. When these are deflected in flight the aeroplane moves about one or more of its three axes. The student needs to know what effect these controls have on the aeroplane's flight path in order to accurately manoeuvre the aeroplane. They also need to see the effect of moving each of these primary flight controls individually, so that any unwanted secondary effect can be countered through coordinated use of the primary flight controls.

Ancillary controls are the throttle, flap and trim. The student needs to know how to operate each of these correctly and what effect their operation will have on the flight of the aeroplane. A clear understanding of the effect of using these controls is important, and then with practice, any adverse effect can be countered.

Objectives

To operate the primary control surfaces and to experience the feel and observe the first aerodynamic effect on the aeroplane in flight.

To operate the primary control surfaces and observe the further (or secondary) aerodynamic effects on the aeroplane in flight.

To operate the ancillary controls and to experience the feel and observe the effect on the aeroplane in flight.

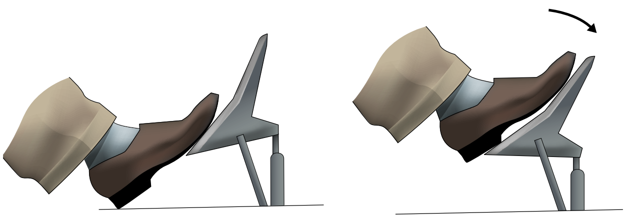
Principles of flight

Primary controls

Describe how the aeroplane is controlled on the ground (see **Taxiing** lesson and Figure 1). Speed is controlled by the hand operated throttle and the main wheel-brakes, while direction is controlled by the use of the pedals linked to the steerable nosewheel.

Figure 1

Steering and braking while taxiing



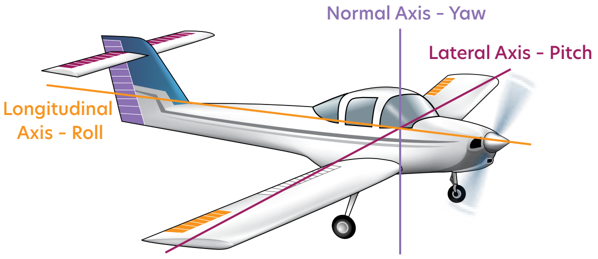
Describe how to hold the aeroplane's controls and explain the concept of dual controls. Identify on your aeroplane which controls are dual, and which are not.

Introduce the terms lift and aerofoil. Describe how lift is produced, with reference to Bernoulli, in the simplest possible terms. For example, if the speed of the airflow is increased the pressure will be reduced and the effectiveness increased, and vice-versa.

Describe the three axes of the aeroplane – lateral, longitudinal and normal (sometimes termed vertical) – and the movement about those axes (use teaching aids).

Figure 2

Aeroplane axes



Drawings, PowerPoints or overheads should be gradually built up and colour coordinated. For example, the lateral axis, the elevator and the word pitch could all be coloured purple (see Figure 2).

Describe how deflection of the controls changes the shape and/or angle of attack, affecting lift and producing the first aerodynamic effect. Start with the elevator, as this is the easiest to describe. Then cover the ailerons and the rudder. If the student has difficulty understanding Bernoulli, angle of attack or pressure, state that movement of the controls deflects the airflow and the tail is pushed up or down as applicable (Newton's third law).

The effect of moving the elevator is to pitch the aeroplane. This changes the position of the aeroplane's nose in relation to the horizon – the aeroplane's attitude – and will consequently affect the aeroplane's speed.

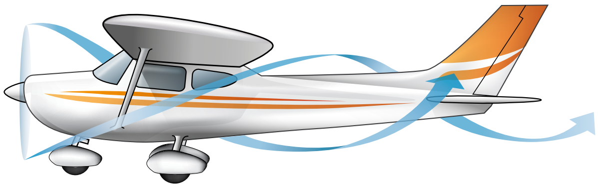
The effect of moving the ailerons is to roll the aeroplane. This banks the aeroplane left or right.

The effect of moving the rudder is to yaw the aeroplane. This moves the aeroplane's nose left or right.

Slipstream should be described as the spiral column of air being forced back by the propeller and the primary controls it affects should be pointed out (see Figure 3). It should be noted that slipstream is present whenever the propeller is rotating, regardless of the aeroplane's speed. The comparison of standing behind the aeroplane, compared with standing at the wingtip, may help the student visualise the effect of this airflow. This highlights that ailerons are unaffected by slipstream.

Figure 3

Slipstream



Describe the rotational nature of the slipstream and its resultant impact on the tail fin. As the aeroplane spends most of its time in cruise, the manufacturer offsets the tail fin, or the thrust line, to negate the resultant yawing tendency. Therefore, at any power setting other than normal cruise, and at any time the power changes, the aeroplane will want to yaw, and compensating rudder inputs are required.

Ancillary controls

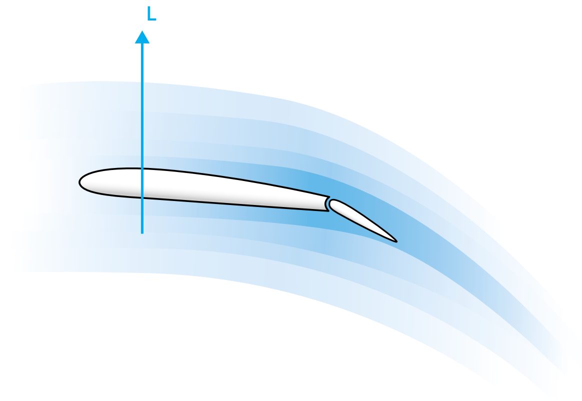
Briefly describe the throttle and its direct connection to the propeller and its effect on the aeroplane's speed. Explain that power is increased by moving the lever (or plunger) forward and decreased by moving the lever rearwards.

Discuss the purpose of trim and how it works. State that most training aeroplanes are fitted with trim tabs to provide sufficient force to hold the primary control surface in the desired position. Emphasise that they are not used to alter the primary control surface's position, they are a pilot aid only. You could also note that trim tabs may be provided on all three primary controls.

Describe where the flaps are located on the aeroplane, how they are operated, how they work (electrically or manually), and the various positions to which they can be selected. It should be noted that flap 'up' means flush with the wings, ie, they do not extend above the wing.

Figure 4

Effect of flap



Describe how the flap changes the shape of the wing and the effect that has on lift, drag, the lift to drag (L/D) ratio, and pitch (see Figure 4). Commonly, in high-wing aeroplanes, the nose pitches up with application of flap, and on low-wing aeroplanes the nose pitches down. The reverse occurs in each case when flap is raised, but importantly all aeroplanes will sink when flap is raised. Describe the actual pitch changes the student will observe as a result of using the flap, and the consequent trim changes that will be required.

The structural airspeed limit for flap extension, and the normal operating range, white arc, should be explained.

Inertia

Because an aeroplane has mass (weight) it is subject to inertia. Explain in very basic terms that inertia is the tendency of a body to remain in its current state. If it has stopped on the ground it will take more power to get it moving than to keep it moving. If you want to decrease the speed in flight, the aeroplane will not slow down instantly, but gradually decelerate. This must be taken into account when changing the speed or the direction of the aeroplane.

Airmanship

Knowing who is physically flying the aeroplane is critical. Get the student into the habit of stating "I have control/you have control." The meaning of "follow me through" should be explained, for example, "I want you to place your hands and feet lightly on the controls and feel what I'm doing, but I retain control."

Explain how to use the clock code to report the relative position, height and distance of other aircraft. Aircraft that appear above the horizon are higher, aircraft on the horizon are at the same level, and aircraft below the horizon are lower. Distance is judged from the known size of the object and is prone to perception errors. For example, a Boeing 787 at 10 miles can look like a Cherokee 140 at 2 miles.

The aeroplane is manoeuvred in the air by visual reference to the horizon and ground features. Visual flight rules mean that cloud must be avoided and the ground or water kept in sight at all times. When you get into the air, point out some major features in your local area, as well as the approximate directions of north, south, east and west, and where your aerodrome is located. Over subsequent briefings the various aspects of VFR flight will be discussed. It is vital that you demonstrate compliance with the various VFR requirements.

I'M SAFE

The **I'M SAFE** checklist should be introduced for the student to complete before leaving home for their next lesson.

I Illness

Do not fly when feeling unwell as this will not only degrade the learning experience but affect all phases of flight.

M Medication

How will the effects of medication be altered by the flight environment, for example, altitude? In addition, why is medication being taken, am I unwell? Do I need to consult a medical examiner?

S Stress

This takes up valuable space in the short-term memory. Getting into an aeroplane straight after an argument or with other personal worries affects your information processing capabilities.

A Alcohol

Even in small amounts, alcohol adversely affects brain functioning. Mixed with altitude and the dynamic three-dimensional environment of aviation, it is deadly. Safe periods of abstinence before flight vary with the individual and the amount consumed.

F Fatigue

This affects not only motor skills but also mental skills. Adequate rest is essential for quality information processing and decision making.

E Eating

A balanced diet and drinking water at regular intervals to prevent dehydration is important. Poor eating habits and/or dehydration can have a detrimental effect on the decision-making process.

In addition, the **I'M SAFE** checklist should be prominently displayed in the briefing room for quick reference before flight.

Aeroplane management

A large-scale photograph of the aeroplane instrument panel and/or cabin layout is a valuable aid.

Give a brief explanation of the purpose of the engine controls. Discuss the sense of movement of these controls.

Throttle

The use of smooth throttle operations should be emphasised. As a guide it should take three seconds to move the throttle from fully CLOSED to fully OPEN, and vice versa. Demonstrate an appropriate grip on the throttle.

Mixture

Explain the type of control (IN / OUT or UP / DOWN) and that when the mixture control is pulled fully OUT or DOWN the fuel supply is cut off from the engine. This is called Idle Cut Off (ICO) and is normally used to stop the engine (not the ignition key – except where there is a solid state ignition system). This will be demonstrated when you shut down at the end of the lesson. Discuss how the mixture control is used to alter the fuel/air ratio and then state that for initial training flights the mixture control is set at the full rich position. Leaning the mixture will be covered in later lessons.

Carburettor heat

Explain the type of control (IN / OUT or UP / DOWN) and the purpose of carburettor heat.

Briefly outline the reasons and conditions for carburettor ice forming, the symptoms of its formation, and the cure. In addition, the reason for applying carburettor heat before closing the throttle, and the conditions under which carburettor ice is most likely to form, should be described. Introducing warm air into the carburettor alters the mixture, so is not normally used at high power settings.

Discuss when you would use carburettor heat on the ground, and the precautions you need to take while doing so.

Temperature and pressure gauges

Gauges such as oil pressure and temperature; cylinder temperature; and fuel pressure, have a normal operating range depicted by a green arc. Red lines indicate operating limits, yellow arcs the cautionary ranges, and often white lines or arcs for other purposes (refer Flight Manual). The importance of monitoring temperatures and pressures for normal readings should be explained. It may sometimes be normal to taxi with oil temperature below the green range (see Flight Manual). On the other hand, it would not be normal to see the oil temperature near the top of the green range after a prolonged descent, even though it's in the green.

Human factors

Describe the VFR see-and-be-seen principle and the importance of a good lookout.

Discuss the limitations of vision, especially on lookout effectiveness. Stress the need to move the head to see around the cabin structures, so that a thorough lookout can be achieved.

Discuss the limitation of the visual system when attempting to detect small stationary objects and alternatively the ability of peripheral vision to detect movement.

Discuss the effects of information overload in relation to human information processing capabilities and the effect on performance. The short-term memory can hold only 7 items ± 2.

Discuss the effects of stress in relation to human information processing capabilities and the effect on performance. As this is the student's first flight it is a busy and new experience. Future lessons build on those before them and the stress reduces.

The benefits of regular practice and the use of a checklist should be encouraged to help with both of these.

Air exercise

Describe the method of taxiing the aeroplane under its own power, stopping and turning, or revise if previously covered.

Basic flight training is based on the concept of attitude – flying by visual reference. It is important to introduce the student to the concept of attitude, being the relationship between the nose (or instrument panel) and wings, and the horizon. Discuss in simple terms how the primary controls are used.

Primary effects

Discuss the effect of movement of each of the primary controls in flight, with emphasis on the sense of movement of the control column and rudder pedals – not the sense of movement of the control surfaces themselves. It is what the student sees as a result of control movement that is important, for example, easing back on the control column pitches the nose up. Emphasise the association between control movement and the natural sense, for example, rotating the control column to the right will cause the aeroplane to roll to the right.

In flight these movements are related to the horizon and confirmed with reference to the instruments. These movements rotate the aeroplane about its axes in a natural sense and always have the same effect relative to the pilot, for example, even when banked, application of rudder will still yaw the nose to the pilot's left or right, but up or down in relation to the horizon.

Further effects

The emphasis here is on aerodynamic effects, sometimes known as aerodynamic cross coupling. When a control movement is made on its own, movement initially occurs around one axis, followed by an undesired movement about another axis. The main point is that these effects only occur when the control is used on its own.

There is no further or secondary effect of elevator.

When aileron is used on its own, the aeroplane will roll, slip, and then yaw towards the lower wing.

When rudder is used on its own, the aeroplane will yaw, skid, and then roll in the direction of yaw.

In both cases, if the controls are left alone, the aeroplane will enter a spiralling descent. The initial slip or skid can be demonstrated with a model as it may be difficult to detect in the air, but the secondary effect will be clearly seen. The balance ball will indicate these effects, but you may not wish to draw the student's attention to this instrument yet.

It should be emphasised that these further or undesirable effects of ailerons and rudder can be eliminated through coordination of these controls, and will be dealt with in later lessons. In this lesson, your purpose is to demonstrate these secondary effects, and as a consequence some manoeuvres in this lesson are uncoordinated.

Airspeed

Discuss the effect of airspeed on the feel of the controls, the aeroplane response rate, and the amount of movement needed to change the flight path. Commonly, the analogy of holding your hand out the car window and moving it from horizontal to vertical at various speeds is used to describe this effect.

At low airspeeds, typically with a high nose attitude, the controls are easy to move, are less effective, and require large movements to bring about a change of flight path. They feel sloppy.

At high airspeeds, typically with a low nose attitude, the controls are harder to move, very effective and require only small movements to bring about a change of flight path. They feel firm.

Slipstream

Describe the effect of slipstream over the elevators and rudder, in relation to high power and idle power settings, at a constant airspeed. At high power the slipstream is increased, and the elevator and rudder are more effective; conversely, at idle power they are less effective. Because the ailerons are situated outside the slipstream, their effectiveness does not change with increasing or decreasing slipstream. On some aeroplanes the elevator may be out of the slipstream because of its height, for example the Piper Tomahawk.

Power

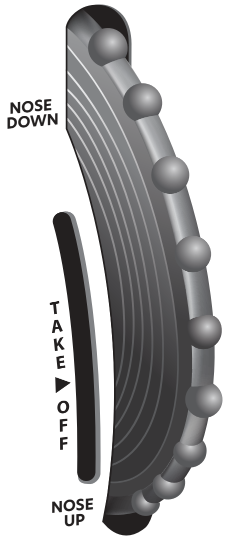
With an increase in power, the aeroplane will pitch up (for reasons that will be explained in a later lesson) and the nose will yaw to the left. Reducing power will result in a pitch down and yaw to the right. Therefore, whenever the power is changed, the pitch and yaw must be compensated for in order to maintain the attitude and balance.

Trim

Describe the method of trimming, if you are holding the elevator back – trim back (nose up), if you are holding the elevator forward – trim forward (nose down) (see Figure 5). Similarly, if the aeroplane is fitted with rudder trim, holding right rudder pressure – move or rotate rudder trim to the right.

Figure 5

Trim control



Flap

When flap is lowered, lift and drag are increased, which causes the nose to pitch. The opposite effect will occur when flap is raised. The change in lift can be felt and the changes in drag can be seen as an airspeed change. Discuss the L/D ratio in context of the initial application of flap on lift compared with the further application and its affect on drag. Any change in pitch will require a change in the trim.

Airborne sequence

Before flight

The importance of inspecting the aeroplane before flight should be emphasised and a demonstration of the full aeroplane preflight inspection given.

During the preflight inspection, point out the major features of the aeroplane, the primary controls and movements, both fixed and adjustable trim tabs, and the effect flap has on the shape of the wing. Point out that while full control movement is acceptable on the ground, only small movements are required in normal flight because the primary controls are situated at the extremities (providing a large moment arm).

Make sure the student is seated correctly, seat secure, seat belts done up, and point out the limitations imposed on the lookout as a result of the cabin structure.

During the taxi, encourage the student to operate the rudder pedals while you hold the control column and operate the throttle. Gradually hand over control of throttle, brakes and control column to the student. Most students will attempt to steer the aeroplane on the ground by rotating the control column – as in a car. They will soon discover that this has no effect on the aeroplane. With a gentle reminder, they will learn to keep the control column neutral and use their feet on the rudder pedals.

Remind the student that a much greater lateral clearance is required than that required for a car.

Point out major ground features and approximate directions of north, south, east and west.

The exercise

Primary effects

Before any demonstration, ensure the student is looking in the right place, ie, outside over the nose (see Figure 6). If the student is looking at the rudder pedals they are unlikely to see the first effect, much less any further effects.

Figure 6

Looking out over the nose

First explain 'nose attitude' and what you mean by it. The line the horizon makes in relation to the aeroplane's nose will be the primary means the student uses to fly the aeroplane. They must have a sound understanding of aeroplane attitude, and how to use it, if they are going to become a pilot.

The primary flight controls and their effects are demonstrated one at a time, with emphasis on the natural sense, to experience the affect themselves. After each demonstration, the student should operate each control one at a time. Ensure that during the rudder movement demonstration and student practice that the wings are held laterally level with aileron. Otherwise the student will see the more obvious roll rather than a pure yaw.

Further effects

Aileron

The aeroplane should be trimmed to fly so that only the lightest of finger and thumb grips is needed on the control column and the feet are only resting on the rudder pedals. Resist the natural tendency to increase backpressure as aileron is applied, otherwise the yaw will not occur. Secondary effects only occur when the primary controls are used on their own.

Drawing the student's attention to the outside reference point, roll the aeroplane with pure aileron using only the finger and thumb. The slip may be difficult to see, however, the yaw and resultant spiral descent should be apparent.

You should ensure three things – firstly that only moderate angles of bank are used, secondly that the student sees how easy it is to stop the spiral descent by using coordinated control inputs, and thirdly that you demonstrate the further effects in both directions.

The student should get the opportunity to move the controls and experience these further effects, but does not need to master it.

Rudder

Once the aeroplane has been returned to straight and level flight, the further effect of rudder should be demonstrated. Gentle application of rudder is all that is required. Once again the skid is difficult to see but the roll and resultant spiral descent is obvious.

Airspeed

Demonstrate the use of elevator by selecting an attitude and watching its resultant effect on airspeed, then give the student the opportunity to experience it.

To effectively demonstrate the effect on airspeed, maintain a constant power setting and vary the airspeed with attitude.

Nose-high attitude equals low or lower airspeed, nose-low attitude equals high or higher airspeed. At this stage there is no requirement to refer to any specific attitude, for example, level or climbing attitude. During this demonstration, the throttle should not be moved but left at a medium power setting so as to make it quite clear that it is the attitude that directly affects the airspeed. During the high airspeed demonstration, however, the throttle will need to be slightly closed unless the aeroplane has a variable pitch propeller and a constant speed unit fitted.

In each case (low and high airspeed), the student should note the feel and response of each primary control. Although any slipstream will affect the feel and response of elevator and rudder in most single engine aeroplanes, the average student on their first lesson will not detect it. It is highly unlikely that the student under these conditions will notice any difference at all regardless of the power setting. Therefore, the student will need to be convinced verbally of what they feel. This is achieved by modulating your voice as each control is moved. For example, low airspeed, elevators light, less effective, BIG movements required – high airspeed, elevators firm, VERY effective, small movements required. The benefit of a constant power setting to give a clear demonstration of attitude to control airspeed far outweighs the considerations of control feel and response.

You can demonstrate at the end of this sequence that all three controls work in relation to the pilot and not the horizon by rolling in some bank, pitching the nose up or down and yawing left or right at the same time. The student should then be encouraged to operate all three controls for themselves.

Use the phrase "pitch the nose up", instead of "pull back on the control column".

Slipstream

Although the effect of slipstream is present at all airspeeds with the propeller rotating, it is easiest to demonstrate at a high power setting and low airspeed. Set up the aeroplane for a constant low airspeed with full power on (eg, a climb). Trim. The student should operate all of the controls, noting the feel of effectiveness for each.

The next step is to reduce power to idle to remove the effects of slipstream and set up the same airspeed as before (ie, a glide). Trim. Now the student again operates all controls, noting the changed feel of those within the slipstream – the elevator and rudder, or just the rudder in the case of the Piper Tomahawk.

To effectively demonstrate the effect of slipstream, maintain a constant airspeed and vary the power setting.

Power

To demonstrate the effects of a power increase or decrease, the aeroplane should be trimmed straight and level at an intermediate power setting. Point out that for this demonstration the feet are off the rudder and the hand is resting lightly on the control column before any power change.

It may be better to demonstrate the effects of reducing power first and then trimming for a descent at a low power setting, for example 1500 RPM, which will provide for a greater pitch change when demonstrating the effects of increasing power. Using full power for this gives a very good demonstration, especially as the aeroplane is trimmed for a descent.

The student should experience compensating for the power changes with appropriate pitch and balance inputs – effectively remaining straight and level (although not yet taught).

The instructor should trim the aeroplane as required.

Trim

The use of elevator trim to relieve control loads and maintain a constant attitude is demonstrated next. Then the student should be given the controls in an out-of-trim state, asked to hold a constant attitude – any attitude will do – asking them to apply trim to unload the control (caution: do not use excessive amounts of trim in case the student suddenly lets go of the control column), while keeping 'the picture' in front the same. When the student can feel that they are pushing or pulling in an effort to maintain the attitude they should move the trim in the appropriate direction to remove the load.

To trim the aeroplane the student should be encouraged to gradually relax their grip on the control column as they neutralise the control forces and, looking outside at the attitude, observe any change. If a change is observed, the desired attitude should be re-selected with the primary flight controls, then pause while equilibrium is re-established, and then re-trim and start the checking process again. As already pointed out, the student at this stage cannot feel subtle control pressures. However, the changing attitude should be relatively easy to detect. The aim is to be able to fly the aeroplane at a constant attitude, using only a finger and thumb grip, and this will not be achieved in one lesson.

Flap

Point out the white arc on the airspeed indicator.

To demonstrate the effect of flap, an attitude should be selected for a suitable speed within the white arc. Trimmed for straight and level, flap is selected, the pitch change for the aeroplane type noted, and the aeroplane re-trimmed. This will not necessarily require the application of full flap to occur. The student can operate the flap, but be aware that observing the pitch change is the more important aspect. From trimmed level flight demonstrate the effect of raising the flap, and the re-trimming required. Also note the changes in lift and drag, and the sink encountered with changes in airspeed.

After flight

After landing, allow the student to revise taxiing and to move the mixture control to ICO on shut down.

The operation of the aeroplane's heater/demister and fresh-air vents can be demonstrated.

After the debrief (see below) tell the student the next lesson will be **Straight and level**, and that you will be using the controls you learned about today to fly straight and level. They may want to do some further reading on this.

Debrief

Comments are given here as a guide to the novice instructor on how to complete the debrief while gaining the experience needed to expand their teaching.

The debrief is an opportunity to revise the exercise, and for both you and the student to reflect on whether the objectives have been met.

Did the student operate the aeroplane's primary controls and experience the first aerodynamic effects? Did they observe the further effects on the aeroplane in flight? Did they operate and experience the ancillary controls and their effects?

If you require verbal confirmation from the student that the objective has been achieved, questions should be phrased to test understanding. Do not ask if the student observed the secondary effects of the primary controls. Preferably, ask the student to describe the further effect of one, or each, of the primary controls.

It is important at this early level to allay any fears or false expectations by reinforcing the fact that there is much to learn. Competence at this stage is not as important as understanding – every lesson will build on the last and give the student every opportunity to improve.

Effects of controls

BASIC CONCEPTS

Objectives

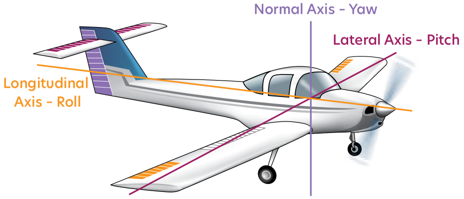
- To operate the primary control surfaces and to experience the feel and observe the first aerodynamic effect on the aircraft in flight.
- To operate the primary control surfaces and observe the further (or secondary) aerodynamic effects on the aircraft in flight.
- To operate the ancillary controls and to experience the feel and observe the effect on the aircraft in flight.

Principles of flight

On the ground

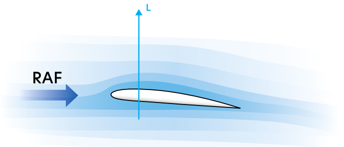
- Control speed with throttle and brakes
- One hand on control column and other on throttle
- Dual controls fitted

Aeroplane axes



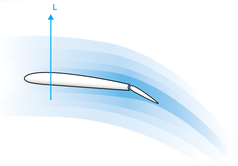
Lift

- As air flows over the wing, increased speed above the wing results in reduced pressure = Lift



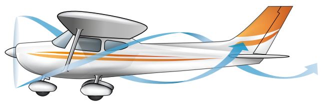
L = lift
RAF = relative air flow

- Lift can be altered by changing the shape of the wing, the angle of attack, and the airspeed



Primary controls

- Elevator pitches aeroplane - changing attitude
- Aileron rolls aeroplane - changing direction
- Rudder yaws aeroplane - balanced flight
- Slipstream strikes rudder and elevator (low-wing)



Ancillary controls

- Throttle affects speed, direct connection to propeller
- Trim tabs provide a force to hold primary controls
- Flap changes shape of wing, increases lift, drag, and affects the L/D ratio - changes pitch, trim change required

Inertia

- Tendency for body to remain in current state - in speed or direction

Airmanship

- "I have control / you have control"
- "follow me through"
- See and be seen
- Clock code, relative height/ distance
- Horizon is main reference
- Land features
- I'M SAFE

Air exercise

Taxi practice

Attitude

- Attitude flying by referencing nose and wings to the horizon

Flying with reference to the horizon

Controls

Axis	Control	Input		1st Effect		2nd Effect	Use
Lateral	Elevator	Control column	forward rearward	Pitch	down up	-	Attitude and Airspeed
Longitudinal	Aileron	Control column	right left	Roll	right left	Slip - Yaw	Direction
Normal	Rudder	Rudder pedals	left right	Yaw	left right	Skid - Roll	Balance

Airspeed

- Increased airspeed - increased control feel, response rate, smaller control movements needed
- Decreased airspeed - decreased control feel, response rate, larger control movements needed

Slipstream

- Increased power → increased slipstream
- Increased flow over elevator → more effective control (not applicable to T-tail aeroplanes)
- Strikes rudder → yaw
- Must balance with rudder

Power

- Decrease in power → nose pitch down and yaw right
- Increase in power → nose pitch up and yaw left
- Must balance with rudder

Trim

- To relieve the pressure
- If holding back pressure - trim backwards
- If holding forward pressure - trim forwards

Flap

- Extending flap → increase in lift and drag → pitch change - trim change required
- Retracting flap → decrease in lift and drag → pitch change - aeroplane will sink

Aeroplane management

- Engine controls
  - throttle
  - mixture
  - carb heat
  - temperatures and pressures
- Flap speed - white arc
- Preflight inspection

Human factors

- Limitations on lookout
- Limitations of memory
- More comfortable with workload
- Uncoordinated lesson by nature

Straight and level

This lesson should start with you asking the student what they did in the last lesson, what do they remember, and determining if they have remembered correctly.

We must be able to fly the aeroplane in a straight line, on a constant heading and at a constant altitude. Maintaining a constant altitude requires a constant attitude and a constant heading requires the aeroplane to be wings level and in balance.

This is the first exercise in coordination for the student, and it's very important that they understand, and can then demonstrate, how the controls they learnt about in the previous **Effect of controls** lesson are used to achieve and maintain a constant heading, constant altitude, constant airspeed, and aeroplane in balance.

It's also an important lesson because it shows the interrelation of a number of variables, such as power, airspeed, pitch and yaw.

The lesson should initially cover configuring straight and level flight at a constant airspeed, and then maintaining it. It's followed by regaining straight and level after a disturbance, and finally straight and level at different airspeeds and power settings.

It's critical that the student understands that straight and level is achieved by referencing the aeroplane's nose attitude directly in front of the pilot with the horizon (where the sky meets the sea, or an imagined line superimposed over terrain or weather), and then checked by reference to the aeroplane's instruments (see Figure 1). Use a moveable 'windscreen view' to show the correct attitude for straight and level flight.

Figure 1

The horizon is where the sky meets the sea – this needs to be imagined and superimposed over terrain or weather where the sea isn't visible.

Objectives

To establish and maintain straight and level flight, at a constant airspeed, constant altitude, in a constant direction, and in balance.

To regain straight and level flight.

To maintain straight and level flight at selected airspeeds or power settings.

Principles of flight

In VFR flight, flying straight and level should only be accomplished with reference to the horizon. Define the horizon for the student and explain how the horizon can be identified if it's not visible, for example with hills or weather in the way.

The four forces

The four forces acting on the aeroplane should be explained.

Weight

Weight acts straight down through the centre of gravity.

Lift

Lift is produced by the wings and acts upwards through the centre of pressure.

Thrust

Thrust is provided by the engine through the propeller.

Drag

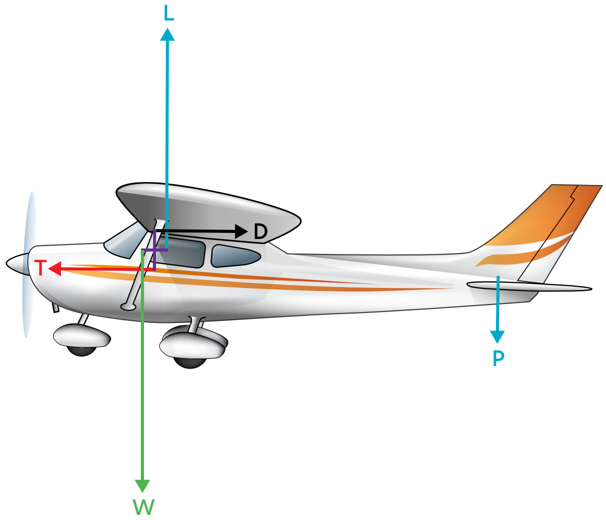
Drag is the force that resists movement of an aircraft through the air.

Equilibrium requires a constant airspeed and constant direction (the combination of these is velocity).
A constant direction is maintained by the wings being level and the aeroplane in balance. Equilibrium is achieved when lift = weight and thrust = drag.

Describe how the arrangement of these forces forms couples. Lift acts through its centre of pressure and is slightly behind the centre of gravity, where weight acts (small moment arm), creating a nose-down pitching couple. The comparative size of the lift and weight forces to thrust and drag forces should be discussed. For general aviation aeroplanes, the lift/drag ratio is said to be about 10:1. Your diagram should reflect this ratio approximately – a picture is worth a thousand words (see Figure 2).

Figure 2

The four forces acting on an aeroplane



The ideal arrangement in training aircraft is for the thrust line to be well below the drag line. This provides a large moment arm to compensate for the smaller forces of thrust and drag, and creates a nose-up couple that balances the nose-down couple of lift and weight.

In the previous lesson **Effect of controls**, the student saw the pitch change when power was increased and decreased. The arrangement of these couples is the reason for the pitch changes. A decrease in power will pitch the nose down into a descent, without pilot input, and an increase in power will pitch the nose up.

In practice, getting the thrust and drag lines separated far enough to balance the lift/weight couple is not possible. Therefore, the tailplane is set at an angle of attack that will provide a down force on the tailplane in level flight, which combined with the large moment arm, balances the forces.

Any further imbalance between the couples, as a result of weight or airspeed changes for example, are compensated for by the elevator.

Lift

Lift is generated by air flowing faster over the top surface of the wing, compared with air flowing under the wing. Air is made to flow faster by shaping the top surface – called camber (see Figure 3).

The formula for lift is:

$$L = C_L \frac{1}{2} \rho V^2 S$$

Where:

C_L is the co-efficient of lift (angle of attack)

½ is a constant

ρ (rho) is the density of the air

V is the airspeed, and

S is the surface area of the wing.

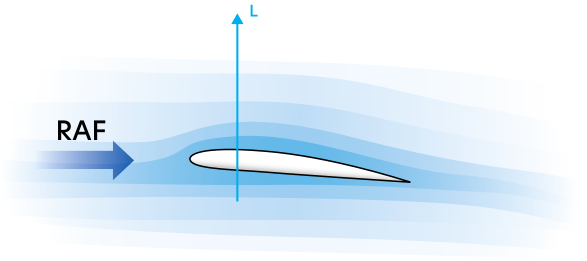
The two elements the pilot can easily control are airspeed and angle of attack, so in essence:

L = angle of attack x airspeed

Angle of attack (**α**) is the angle between the relative airflow (RAF) and the chord line of the aeroplane's wing.

Figure 3

Lift



The most efficient angle of attack is approximately 4 degrees, but as no angle-of-attack indicator is fitted to light aeroplanes, the airspeed is used as a guide to the aeroplane's angle of attack.

In order to keep lift constant, any change in the angle of attack must be matched by a change in the airspeed. For example if airspeed increases, less angle of attack is required to maintain a constant lift. A decrease in airspeed will require an increase in the angle of attack to maintain constant lift and consequently altitude.

Performance

Introduce the concept of:

Power + Attitude = Performance

Power is set by reference to RPM – use the organisation's recommended RPM setting for training flights. In the example below we have used 2200 RPM.

The attitude will depend on the aeroplane type. In this example, we will position the top of the instrument panel four fingers below the horizon.

In this case the performance we want is a constant altitude, direction and airspeed – straight and level.

Power	+	Attitude	=	Performance
(2200)		(eg, four fingers)		(straight and level)

Airmanship

Discuss the lateral boundaries of the training area and the importance of managing the flight to remain within them.

Revise 'I have control – you have control'.

Aeroplane management

Stress the importance of smooth but positive control movements.

Operation of the mixture control has been explained in the previous lesson. During initial training, as a result of regular altitude and power changes, the mixture is normally left in the full rich position.

Revise why carburettor heat is set to HOT at power settings below _____ RPM (commonly the green arc or 1900–2000 RPM).

Human factors

Review the visual limitations discussed in the last lesson and how blind spots affect a good lookout.

There is a lot of information for the student to absorb in the early lessons, so reassure the student that there will be plenty of time to master these skills.

Air exercise

Identify the horizon, and what attitude is required relative to the horizon, with the appropriate power setting, to establish and maintain straight and level flight.

Power	+	Attitude	=	Performance
(2200)		(eg, four fingers)		(straight and level)

With the use of the 'windscreen view' show the attitude in the correct position as well as in the too low and too high positions.

Establish straight and level

Establishing straight and level flight is achieved by using the mnemonic **PAT**.

P Power

Set the power for selected (normal) straight and level performance.

A Attitude

The attitude for straight and level is made up of three elements.

Elevator	Set the nose attitude – for level (eg, four fingers)
Aileron	Wings are level relative to the horizon – for straight
Rudder	In balance – for straight

If a constant direction is not being maintained on the reference point (and the DI should confirm this) either the wings are not level, or the aeroplane is out of balance, or both.

Balance is confirmed with the balance ball indicator. The method used to achieve balance is 'stand on the ball'. If the ball is out to the left, increased pressure on the left rudder pedal is required. This is a pressure increase, more than a movement and 'stand' implies continued pressure. Once the ball has been centred, reducing pressure will allow it to move out again.

The aeroplane is kept in balance to not only keep the aeroplane flying straight, but also for best efficiency by keeping drag to a minimum and achieving the best airspeed.

If the correct level attitude has been selected the airspeed will be about ___ knots. If the correct power setting is maintained the aeroplane will maintain altitude, and if the wings are level and balance maintained the aeroplane cannot turn. Therefore, the objective to fly at a constant airspeed, constant altitude, constant direction, and in balance is achieved.

T Trim

Take the time to teach this thoroughly, make sure the student relieves all of the control pressures so that their hands can come off the controls and the aeroplane remains level.

Maintaining straight and level

Maintaining straight and level is achieved by using the mnemonic **LAI**.

L Lookout

In a scan loop ahead, look out to the left and scan 20 degrees for 2 seconds from left to right, passing over the nose of the aeroplane.

A Attitude

Ensure the attitude is correct relative to the horizon and, more importantly, constant.

I Instruments

Used to confirm accurate flight – not set it. From right to left the instruments are scanned, and this brings the scan back to the left side of the aeroplane and the process starts again.

During the instrument scan, only those instruments important to the phase of flight are read. In this case the altimeter will probably be scanned on every sweep, with oil pressure and temperature scanned every 10th sweep.

Regaining straight and level

1. Check the airspeed, and the power setting – set the correct power setting. If the airspeed is decreasing, increase power, if the airspeed is increasing, decrease power.
2. Check the nose attitude – set the attitude for straight and level.
3. Check the wings are level and the ball is in the middle – level the wings, centre the ball.
4. Reset the power after making any changes to the attitude.
5. Check **PAT** (power, attitude, trim).

For small altitude adjustments of less than 150 feet, the attitude is altered with elevator, and when the desired altitude is regained the correct level attitude is set, held and trimmed. For bigger altitude adjustments power is usually altered.

Straight and level at different airspeeds and power settings

Power + Attitude = Performance

It should be emphasised that every time power or airspeed is altered, a change in rudder pressure will be required to maintain balance. Therefore, during those phases of flight where power or airspeed are changing, rudder will need to be applied to maintain balance. In addition, when rudder is being used to centre the ball, the wings must be held laterally level with aileron.

List the various power, airspeed and attitude settings required to maintain straight and level flight. An example is shown below.

Power	2200	1800	2500
Airspeed	80–90 knots	60 knots	110 knots
Attitude	normal	high	low

As can be seen, a high power setting means a higher airspeed, requiring a lower nose attitude. Conversely a low power setting means a low airspeed, requiring a higher nose attitude.

Airborne sequence

On the ground

Show the student the preflight inspection again, and have them follow you through, pointing out what they would be looking for.

- Make sure the student's seat is properly adjusted.
- Talk the student through the engine start up.
- Revise taxiing.
- Talk the student through the checks.

The exercise

Have the student follow you through with the takeoff, and once safely airborne hand over control to the student, showing them the climb attitude (which will be taught next lesson) and reference point you want them to hold.

On the way out to the training area teach the horizon concepts and point out the local landmarks.

Establish the aeroplane in straight and level.

Point out the horizon to the student – let them note the attitude when level. Demonstrate an attitude that is too high and an attitude that is too low.

Configure the aeroplane, using **PAT**, in straight and level flight at normal cruising power. Once the student has recognised the attitude, and noted that the wings are level and the aeroplane is in balance, hand over control.

Talk the student through establishing straight and level using **PAT** and maintaining straight and level using **LAI**.

Make minor deviations away from straight and level and talk them through regaining it.

Show the student the effect of a marked imbalance. They should be able to 'feel' that the aeroplane is out of balance. Then show a slight imbalance. This is much harder for them to 'feel' or detect, and that is why the balance ball is used to correct slight imbalances. Show them how to correct for an imbalance.

You should then give the student some practice at regaining straight and level by disturbing the aeroplane in roll, pitch, trim and power.

Demonstrate the lookout technique, outside and inside.

Once the student is comfortable with regaining straight and level, demonstrate the different power settings, and corresponding airspeed and attitudes, required for straight and level flight. Finish by letting them practise returning to straight and level flight by changing the power, adjusting the attitude and remaining in balance.

On the return to the aerodrome, point out the local landmarks again, and show them the descending attitude, ready for the next lesson.

After flight

Debrief the student.

Next lesson will be **Climbing and descending**, they may want to do further reading on this, and ask them to think about the attitudes for climbing and descending they saw in this lesson.

Straight and level

BASIC CONCEPTS

Objectives

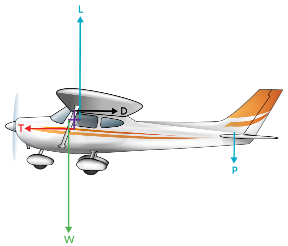
- To establish and maintain straight and level flight, at a constant airspeed, constant altitude, in a constant direction, and in balance.
- To regain straight and level flight.
- To maintain straight and level flight at selected airspeeds or power settings.

Principles of flight

- The horizon is the line where the sea meets the sky.
- All flying references the aeroplane's nose with the horizon.

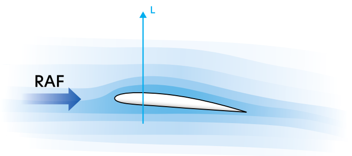
The four forces

- Lift, Weight, Thrust, Drag
- Equilibrium when Lift = Weight and Thrust = Drag
- Forces don't act through the same point → moment arms → couple
- Lift and Weight couple balanced by tailplane force
- Changes in Thrust → pitch changes



Lift

- Air over the top accelerates compared with air passing under the wing
- $L = C_L \frac{1}{2} \rho V^2 S$
- L = Angle of attack x airspeed
  - Angle of attack altered with elevator



Performance

- Power + Attitude = Performance

Air exercise

- Horizon
- Power setting
- Attitude for level

Establishing straight and level

Power	set for straight and level		
Attitude	elevator aileron rudder	set nose wings level in balance	attitude relative to horizon no yaw – stand on the ball
Trim	to relieve pressure – hands off		

Maintaining straight and level

Lookout	ahead
Attitude	eg, four fingers
Instruments	to confirm – not set Altimeter, DI, TC, RPM checked every time Other instruments and gauges, less frequently

Regaining straight and level

1. Airspeed and power setting correct
2. Attitude correct for straight and level
3. Wings level and balance ball centred
4. Reset power
5. P A T

Straight and level at different airspeeds

- Any changes in power must be balanced with rudder
- While moving rudder wings must be kept level

Power + Attitude = Performance

Power	2200	1800	2500
Airspeed	80–90 knots	60 knots	110 knots
Attitude	normal	high	low

Airmanship

- Lookout
- Situational awareness, training area boundaries, clear of cloud
- "I have control / you have control"

Aeroplane management

- Smooth throttle movements
- Mixture rich
- Carb heat

Human factors

- Blind spots
- New learning consistently reinforced in later lessons

Climbing and descending

This lesson builds on the coordination skills learnt in the previous lesson, straight and level. Check with the student what the important elements of the last lesson were. Have they remembered the attitudes you looked at last time, and that all the controls need to be moved in a coordinated way?

There are a large number of power changes made during this air exercise and it is important the student reviews and practises the coordination of elevator and rudder adjustments with changes in power.

There are generally four types of climb: best angle, best rate, cruise, and recommended (for visibility and engine cooling). There are also generally three types of descent: glide, powered, and cruise.

It is recommended you teach the best rate climb and the glide, with a demonstration of the others as time permits.

The last lesson was **Straight and level**. Now we must learn how to climb and descend to and from straight and level flight, so that we can move towards the circuit lessons.

Objectives

To enter the climb and the descent from straight and level flight.

To maintain a climb and a descent at a constant speed, constant rate, in a constant direction, and in balance.

To level off at specific altitudes.

Principles of flight

Climbing

To maintain a constant speed and direction, the aeroplane must be in equilibrium, as discussed in the straight and level lesson. We demonstrate the relationships between the four forces in the climb to show that the aeroplane is still in a state of equilibrium when climbing.

There is no requirement to prove anything in a preflight briefing. Statements illustrated with diagrams are sufficient to support the air exercise.

There is a common misconception that in the climb the lift is increased, since if lift must equal weight in level flight, it might appear logical that lift should be increased to climb, but it is not so. Drawing the forces to show that lift is not increased in the climb - but is slightly reduced - should illustrate that the aeroplane is in equilibrium during the climb.

The most important concept the student should grasp, in simple terms, is that in order for an aeroplane to climb, thrust must be equal to drag plus the rearward component of weight (T = D + RCW). The rate at which the aeroplane will climb depends on how much more power is available. Lots of additional power available will mean a high rate of climb.

The forces acting on the aeroplane in a climb

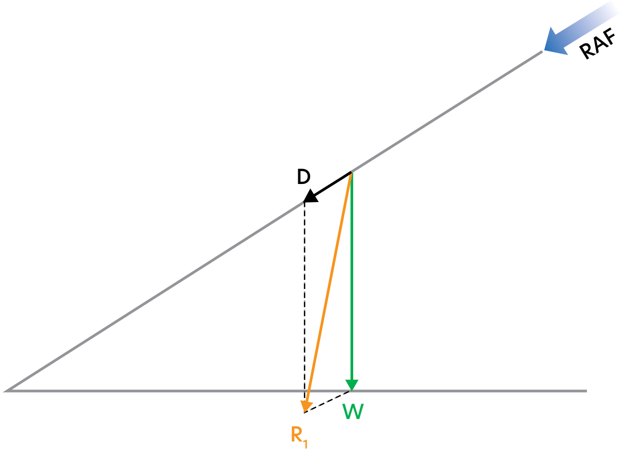
From the previous lesson the student will know that there are four forces acting on the aeroplane: lift, drag, thrust, and weight, and that in straight and level flight, the aeroplane was in equilibrium. The same is true of the climb - the forces are in equilibrium. They will also know about relative airflow (RAF).

Explain that for simplicity your diagram will show the forces acting through just one point, and that the climb angle has been exaggerated for clarity.

Start by showing weight and drag and their resultant, R1 (see Figure 1).

Figure 1

Weight and drag in the climb



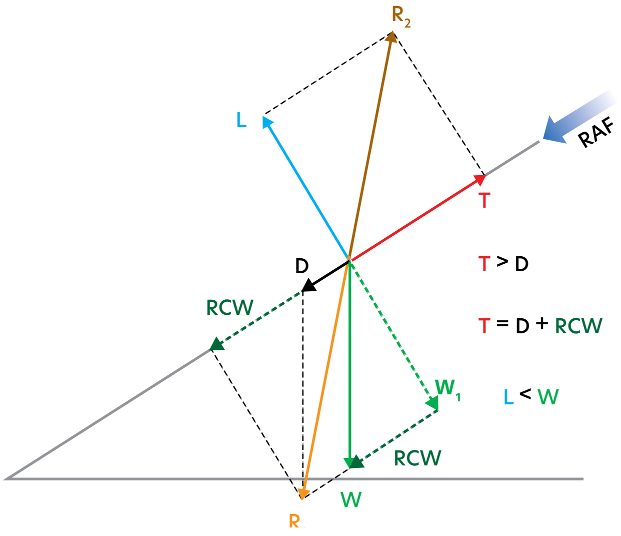
Make the statement, “Since the aeroplane is in equilibrium, there must be a force equal and opposite to the resultant R1”.

Then, draw a line from the central point, equal and opposite to R1 and label this R2.

Resolve R2 into its two components, lift and thrust (see Figure 2).

Figure 2

Lift and thrust in the climb



The relationship of the four forces is next explained, as was done in straight and level. Starting with thrust (T) and drag (D).

In straight and level flight thrust equals drag (T = D).

In a climb, thrust must increase to equal drag plus the rearward component of weight (T = D + RCW).

It should be clear to the student from your diagram, that in a steady climb, "thrust is ______ than drag."

Why then, does the aeroplane not accelerate?

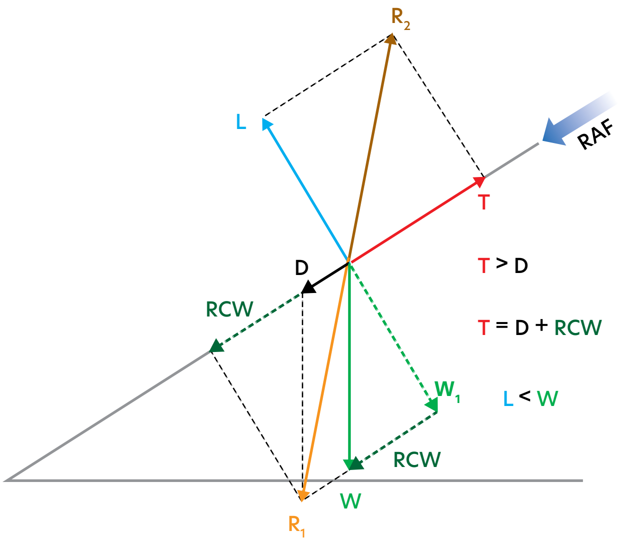
To resolve this question, break weight (W) down into its two components, with the rearward component of weight (RCW) added to the drag vector.

Thrust is equal to the drag plus the ______.

You may wish to finish off the parallelograms to tidy up your resolution of vectors. The end result looks like Figure 3.

Figure 3

Forces acting on an aeroplane in the climb



Finish off by asking the student what force controls the climb. And is there a limit to that force? How might that limit the climb?

Climb performance

Having discussed the forces in the climb, the various factors affecting the climb performance are discussed.

Power

You have just established that the more power available, the better the climb performance.

Altitude

Engine performance (power) decreases with altitude, so there will be a limit to how high the aeroplane can climb.

In addition, anything that opposes thrust is detrimental to climb performance.

Weight

The greater the weight, the greater will be the RCW (rearward component of weight). Therefore, weight reduces the rate of climb and the angle.

Flap

Increases lift and drag and alters the lift/drag ratio. Since drag opposes thrust, any increase in drag will reduce the rate and angle of climb.

Wind

Affects only the climb angle and the distance travelled over the ground (the range) to reach a specific altitude.

Table 1

The various configurations for the four types of climb in your training aeroplane are:

Performance	=	Power	+	Attitude
Best rate climb		full power	no flap	_____ knots
Best angle climb		full power	no flap	_____ knots
Cruise climb		_____ RPM	no flap	_____ knots
Recommended climb		_____ RPM	no flap	_____ knots

Let the student know that you will be using the best rate climb for this lesson and you will demonstrate the others. They may experience these climbs at this stage but their application will become clearer in later lessons.

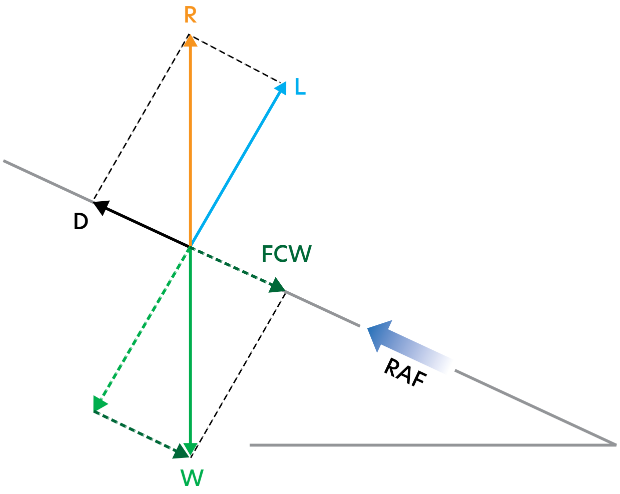
Descending

Equilibrium is required for a steady descent. If, while in level flight, the power is removed there will be no force balancing the drag. In order to maintain flying speed the nose must be lowered.

With the nose lowered and weight still acting down towards the centre of the earth, there is now a forward component of weight (FCW) that balances drag. State that for equilibrium there must be a force equal and opposite to weight. This force R is made up of lift and drag. Therefore, the aeroplane is in equilibrium (see Figure 4).

Figure 4

Forces acting on an aeroplane in the descent



Point out that the relative airflow is now coming up the slope to meet the aeroplane and therefore the angle of attack is still approximately 4 degrees.

Power

Power controls the rate of descent (ROD), the more power used, the less the ROD. Power also reduces the descent angle and increases the distance travelled over the ground, increasing the range from a given altitude.

Lift/drag ratio

The ratio of lift to drag is a measure of the efficiency of the wing. For example, the higher the lift to drag ratio, the further the aeroplane will glide (its range). Another way to think of it is the L/D ratio determines the steepness of the glide, or descent angle.

If you then change this ratio by increasing the drag (by extending flap or flying at an incorrect airspeed) a greater forward component of weight is required to balance the drag – steepening the flight path.

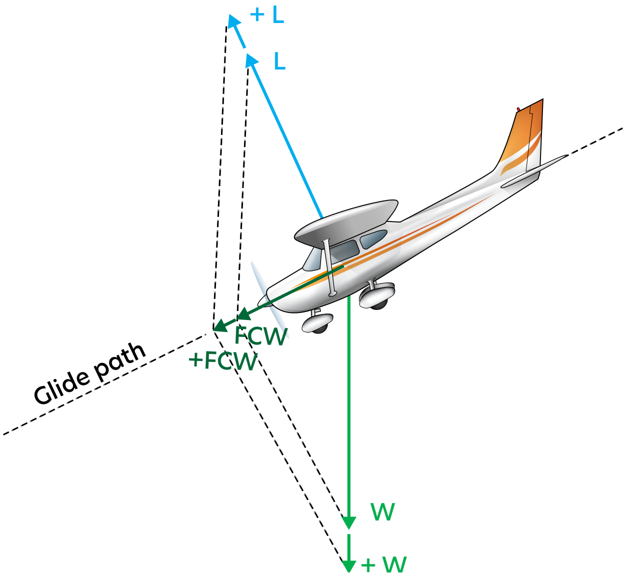
Weight

A change in weight does **not** affect the descent angle. With an aeroplane flying at its best L/D ratio, an increase in weight will increase the FCW, increasing the speed down the slope, and therefore the rate of descent, but not the descent angle.

Show this by increasing the length of the weight vector in your diagram. The FCW increases the airspeed down the slope, and the increased airspeed leads to an increase in lift and drag (with the L/D ratio remaining unchanged), and all the forces remain in equilibrium (see Figure 5).

Figure 5

Effect of change in weight on descent



Flap

The increased drag produced by the flap requires an increased FCW to maintain equilibrium and thereby steepens the descent, increases the ROD, and reduces the range.

Wind

Affects only the descent angle and the range from a given altitude.

Table 2

The various configurations for the three types of descent in your training aeroplane should be stated, for example:

Performance =	**Power**	**+**	**Attitude**
Glide	propeller windmilling	no flap	_____ knots or _____ ft/min ROD
Powered	1500 RPM (guide only)	flap as required	_____ knots or _____ ft/min ROD
Cruise	_____ RPM (within green range)	no flap	_____ knots or _____ ft/min ROD

Teach the glide first, then the others can be taught as a variation of the glide.

Airmanship

Situational awareness should be briefly described as a three-dimensional assessment of what has been, what is, and what will be. Explain that this skill takes time to develop, but should be practised at every opportunity.

Introduce the concept of threat and error management in simple and practical terms, as applicable to climbing and descending.

The met minima requirements for VFR flight outside controlled airspace, below 3000 feet AMSL or within 1000 feet of the ground should be revised – refer to the *NZ Airspace* poster and *VFR Met Minima* card.

Discuss minimum height requirements. For example, 500 feet AGL minimum over unpopulated areas, 1000 feet AGL minimum over built-up areas but not less than that required to glide clear of the populated area. Stipulate any club or organisation minimum safe heights.

Discuss the restrictions on lookout in relation to high and low nose attitudes. Explain that there are at least two methods for ensuring the area ahead is clear: lowering the nose every 500 feet; or making gentle S-turns. While climbing out to the training area you will use gentle S-turns.

As the exercise does not involve prolonged climbs or descents – usually no more than 500 feet – there is no need to use either method, but a good lookout must be maintained, particularly before starting the climb or descent.

Revise situational awareness in relation to aeroplane positioning, lateral and vertical limits of the training area, and VFR met minima requirements within the training area.

Revise the **I'M SAFE** checklist, reminding the student to complete this before leaving home.

Aeroplane management

Throttle

The student has informed you of the power setting that will give the best climb performance. You need to point out that not all aeroplanes can climb on full power continuously.

If the organisation or aeroplane has an rpm limit for the prolonged climb, it should have been explained in the desired configuration above, if not then explain it here.

The detrimental effects of a prolonged glide should be discussed, for example, plug fouling and excessive cylinder-head cooling. This should lead to a discussion on the advantages of a powered descent.

Mixture

The use of full rich mixture to aid engine cooling and prevent detonation at power settings above 75 percent (below 5000 feet) should be explained.

During training, it is common practice to use full rich mixture in the descent (discuss mixture control in prolonged descent from altitude).

Carburettor heat

Carburettor heat is not normally used at climb power settings because of the detrimental effect of carburettor heat on engine performance, and therefore climb performance.

In the descent, hot air is selected before reducing power because of the increased likelihood of carburettor icing.

Temperature and pressure gauges

In the climb it is normal to see an increase in oil and cylinder head temperatures with a decrease in oil (and fuel) pressure. In the descent it is normal to see a decrease in oil and cylinder-head temperatures and an increase in oil (and fuel) pressure.

The normal readings for this aeroplane in the climb and descent should be discussed. In addition, how to prevent these readings reaching their limits in an air-cooled engine should be discussed. For example: lowering the nose attitude to climb at a higher airspeed or, if necessary, levelling off for a short period, or during descent increasing power every 1000 feet to warm the engine oil and clear the spark plugs of carbon deposits, or the use of a powered descent.

Human factors

Discuss the effects of trapped gases in the middle ear and sinus in relation to their expansion with increasing and decreasing altitude. In general, a comfortable rate of descent for a fit person is 500 feet per minute. Discuss and demonstrate the 'Valsalva manoeuvre'.

Discuss the dangers of diving and flying.

Discuss the effects of altitude on vision with regard to empty sky myopia (short-sightedness) or focal resting lengths, reinforcing the need for a clean windscreen and systematic scan technique. Also discuss the effect of the background on object detection.

As a result of high power settings, noise levels will be increased and it is appropriate to discuss the effects of exposure to noise as well as how to prevent hearing damage.

Air exercise

Planning the lesson sequence will vary depending on such factors as an appropriate cloud base, airspace ceiling, and the ability to achieve both climbing and descending objectives.

The air exercise concentrates on improving the coordination skills learnt in the previous lessons, by entering and maintaining the climb and descent, while maintaining the aeroplane in balance, and regaining straight and level. It is particularly important to reinforce the need to balance power changes with rudder.

Introduce some basic radio calls.

Climbing

Discuss the nose attitude position in relation to the horizon for the selected climb configuration.

Entry to the climb is taught as **PAT**, reinforcing the concept that climb performance depends on power. Since increasing power smoothly (stop the resulting yaw with rudder) will cause the nose to pitch up, power and attitude should be considered a coordinated movement, and no engine over-speed should occur.

Power + Attitude = Performance

P Power

Check mixture rich, smoothly increase power (while stopping the yaw with rudder) to full power or maximum continuous; keep straight using the reference point.

A Attitude

With elevator, select and hold the attitude for the nominated climb, maintaining wings level with aileron and balance with rudder.

T Trim

Remove excessive loads by trimming back. Once performance has been confirmed, trim accurately to maintain a constant attitude.

If the correct climb attitude is selected the airspeed will be _____ knots (exactly). If both the attitude and the power setting are correct, the resulting performance is a steady rate of climb of _____ ft/min (500–700 approx). If the wings are held level and balance maintained, the aeroplane cannot turn. Therefore, the objective of entering and maintaining the climb has been achieved.

Maintaining the climb incorporates the **LAI** scan, with those instruments pertinent to the climb being scanned most frequently for accurate flight.

If the airspeed is not correct, then the attitude is incorrect, and performance will be affected. Emphasise that the airspeed is altered by reference to attitude, and that due to inertia once a change has been made, a smaller change in the opposite direction will be required to hold the new attitude. These corrections are commonly stated as "change – check – hold – trim".

To regain straight and level from a climb, the mnemonic **APT** is used.

A Attitude

Anticipate the required altitude by approximately 10 percent of the rate of climb, ie, a climb of 500 feet per minute will require an anticipation of 50 feet.

With the elevator, select and hold the level attitude. The airspeed will increase only gradually, because the aeroplane must overcome inertia. To assist this process, climb power is maintained until a suitable airspeed has been achieved. As the airspeed increases the aeroplane's nose will want to pitch up, requiring subtly increasing forward pressure on the control column to maintain the correct attitude. The wings should be kept level in relation to the horizon, and rudder adjusted to keep straight on the reference point.

P Power

Through _____ knots, decrease power to _____ rpm. The resultant pitch change and yaw must be compensated for, remember to use smooth throttle movements.

T Trim

Accurate trim cannot be achieved until equilibrium has been established. However, obvious control loads may be reduced immediately, then followed by accurate trimming.

Once the instruments confirm level flight is being maintained, the aeroplane can be accurately trimmed to maintain the selected **attitude** and reference point.

Descending

Discuss the nose attitude position in relation to the horizon for the descent.

Entry to the descent is taught as **PAT**.

Power + Attitude = Performance

P Power

Check the mixture is rich, carburettor heat HOT, smoothly close the throttle and keep straight using the reference point.

A Attitude

With the power reduction, the nose will want to pitch down. With elevator, hold the level attitude until the nominated descent airspeed is almost reached (allowing for inertia), and then select and hold the attitude for the nominated descent. Maintain wings level with aileron, and balance with rudder.

T Trim

Remove excessive load by trimming (usually backwards) and once the performance is achieved, trim accurately to maintain a constant attitude.

With the correct descent attitude selected the airspeed will be _____ knots exactly. If the attitude is correct, and the power is set correctly, the resulting performance is a steady rate of descent of _____ ft/min (approx 500). If the wings are held level and balance maintained, the aeroplane cannot turn. Therefore the objective of entering and maintaining the descent has been achieved.

Maintaining the descent incorporates the **LAI** scan, with those instruments pertinent to the descent being scanned most frequently for accurate flight.

If the airspeed is not correct then the attitude is incorrect. Emphasise that the airspeed is altered by reference to attitude and that, due to inertia, once a change has been made a smaller change in the opposite direction will be required to hold the new attitude. "Change - check - hold - trim."

To regain straight and level from the descent, the mnemonic **PAT** is used. Because of inertia, power leads the sequence to arrest the descent.

P Power

Anticipate the required altitude by approximately 10 percent of the rate of descent, ie, a descent of 500 feet per minute will require an anticipation of 50 feet.

Carburettor heat COLD, smoothly increase power to cruise power (balancing with rudder).

As airspeed increases, rpm may increase slightly, requiring another throttle adjustment.

The power change will cause the nose to yaw, if not corrected with rudder, and to pitch up. The pitch-up tendency encourages a coordinated movement because the next step is...

A Attitude

With the elevator, select and hold the level attitude. Maintain wings level with aileron, and balance with rudder.

T Trim

Remove obvious loads, and when straight and level has been confirmed through **LAI,** trim accurately to hold the correct attitude.

Airborne sequence

On the ground

Ask the student to carry out the preflight inspection while you observe.

Ask the student to taxi, and point out the obstructions and possible threats as they go. Depending on the level of comfort of the student at this stage of their training, you may like to introduce the checklists to them and get them to follow you through, or do the checks as you call them out.

The exercise

Depending on their level of comfort, you may either want to let the student complete the take-off, while you follow them through, or talk them through the experience.

On the way out to the training area demonstrate the climbing attitude relevant to the horizon and the corresponding speed. Ask the student to point out the landmarks they were shown in the last lesson.

Review straight and level with emphasis on a specific altitude.

From straight and level nominate a reference point and altitude to climb to – considering cloud and overlying airspace restrictions. Demonstrate the climb and the level off to resume straight and level at a specific altitude. Anticipation of the altitude is required.

The student should now practise the entry to the climb, maintaining the climb and the level out until proficient. Then have the student establish the aeroplane in another climb and demonstrate different climb attitudes and corresponding speeds, noting rate of climb effect, and the effect of flap, especially flap retraction in a climb, in preparation for the go around in the circuit lessons. Once it has been demonstrated, encourage the student to make the flap selections and note the effect it has on the attitude, airspeed, rate of climb and trim.

Have the student establish in straight and level on a reference point. Nominate a reference point and altitude to descend to – considering minimum height restrictions. Remind the student that you will be using the glide, with the throttle closed. Demonstrate the glide and the level off to resume straight and level at a specific altitude. Anticipation of the altitude is required.

The student should now practise the entry to the descent, maintaining the descent and the level out. Once the student has completed the sequence, have the student establish the aeroplane in another descent and demonstrate the effect of power and flap. Once it has been demonstrated, encourage the student to make the flap selections and note the effect it has on the attitude, airspeed, rate of descent and trim.

Practise the climb and descent as required, so that the student is comfortable with the entry, maintenance, and exit, and coordinates rudder with power changes.

On the way back to the aerodrome, demonstrate the cruise descent, including the selection of power and rate of descent appropriate for the conditions. Remind the student that there will be time to practise this on every flight.

After flight

The next lesson will be turning. Ask the student to read any notes they have on turns and to remember the attitudes they saw in this lesson.

Ask the student what they learnt about power changes and rudder use.

Climbing and descending

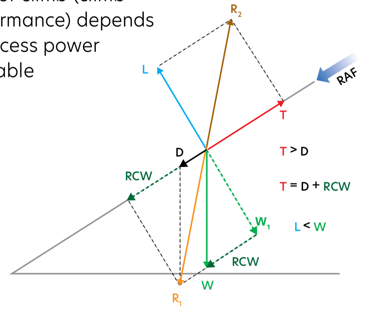
Objectives

- To enter the climb and the descent from straight and level flight.
- To maintain a climb and a descent at a constant speed, constant rate, in a constant direction and in balance.
- To level off at specific altitudes.

Principles of flight

Climbing

- Aeroplane is in equilibrium when climbing
- Lift is not increased
- **T must be greater than D**
- Rate of climb (climb performance) depends on excess power available



Climb performance

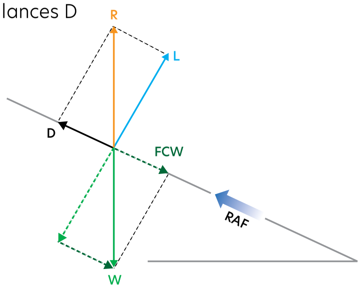
Power	More power better climb performance
Altitude	Limits the performance
Weight	↑ weight – ↓ rate of climb
Flap	↑ drag – ↓ rate of climb
Wind	Affects climb angle and distance in climb

Climb configurations

Performance	Power	Attitude
Best RoC	full	________ kt
Best AoC		________ kt
Cruise		________ kt
Recommended		________ kt

Descending

- Aeroplane is in equilibrium when descending
- Flying speed maintained by lowering nose attitude
- FCW balances D



Descent performance

Power	Controls rate of descent
L/D ratio	Efficiency of wing, steepness of glide
Weight	↑ weight ↑ FCW – ↑ speed down slope
Flap	Needs ↑ FCW to balance D – ↑ rate of descent
Wind	Affects descent angle and range

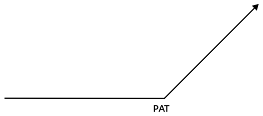
Descent configurations

Performance	Power	Attitude
Glide	idle	________ kt
Powered		________ kt
Cruise		________ kt

Air exercise

Climbing

Entry



Power	mixt RICH, full power, balance
Attitude	climb attitude, wings level, balance
Trim	to maintain attitude

Airspeed = ________ RoC = ________

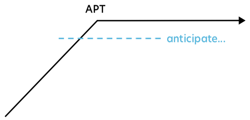
Airspeed controlled with attitude

Maintaining

Lookout
Attitude
Instruments

Change – check – hold – trim

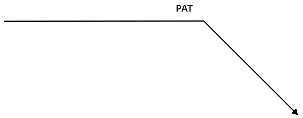
Exit



Attitude	select and hold S+L attitude, adjust as speed increases, balance
Power	wait for aeroplane to accelerate, then set cruise power, balance
Trim	to hold S+L attitude

Descending

Entry



Power	mixt RICH, carb heat HOT, close throttle, balance
Attitude	hold S+L attitude until glide speed, then set glide attitude
Trim	to maintain attitude

Airspeed = ________ RoD = ________

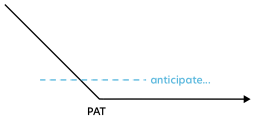
Airspeed controlled with attitude

Maintaining

Lookout
Attitude
Instruments

Change – check – hold – trim

Exit



Power	carb heat COLD, increase power to cruise, balance
Attitude	simultaneously set to S+L, balance
Trim	to hold S+L attitude

Airmanship

- Situational awareness – what was, is, and will be
- VFR Met minima
- Minimum and maximum heights
- Lookout – restrictions
- I'M SAFE

Aeroplane management

- Smooth throttle movements
- Mixture RICH
- Carb heat HOT for descent
- Temperatures and pressures

Human factors

- Trapped gases in ears
- Diving
- Empty sky myopia
- Noise

Medium, climbing and descending turns

A medium turn is defined as a turn using up to 30 degrees angle of bank. Climbing and descending turns are combined with medium turns within this briefing, but your organisation may prefer to present a separate briefing; consult with your CFI.

The turning lesson builds on the previous lessons. The student will improve their attitude control and learn to smoothly and accurately coordinate aileron and rudder. During the roll-out the student will need to allow for aeroplane inertia and use smooth control inputs to regain the original reference point and height.

During this lesson the student will have the opportunity to practise straight and level, climbing, and descending. This is the stage at which the lookout technique is taught specifically, with the emphasis on the 20 degree per 2 second visual scan technique.

Define the medium turn and explain angle of bank. Explain that if you wanted to change direction, you wouldn't normally complete an entire circle. However, in order to reduce the chance of disorientation we complete a 360 degree turn and regain straight and level on the original reference point.

Objectives

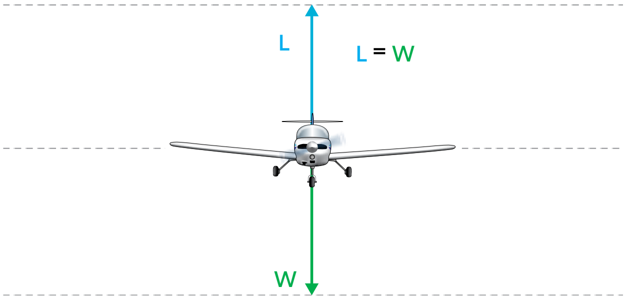
- To change direction through 360 degrees at a constant rate, using 30 degrees angle of bank, while maintaining a constant altitude and keeping the aeroplane in balance.
- To complete a medium turn while climbing and while descending.

Principles of flight

Start with a diagram of the aeroplane flying into the board (so that the student is correctly orientated) and revise how lift equals weight in straight and level flight (see Figure 1a).

Figure 1a

Straight and level flight



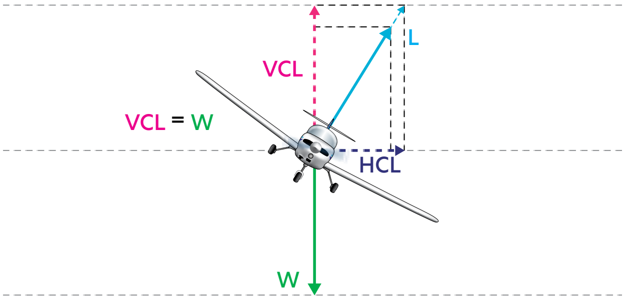
Lift vector

It is very important that the student understands that in order to turn the aeroplane an acceleration towards the centre of the turn must be provided. This is done by banking the aeroplane with aileron. Breaking lift down into its two components shows that it is the horizontal component of lift (centripetal force) that provides this acceleration towards the centre of the turn.

With the lift vector inclined, the vertical component of lift no longer supports the aeroplane's weight. To maintain a constant altitude or height, the total lift vector must be increased so that the vertical component now equals the weight. The appropriate amount of backpressure on the control column achieves this (see Figure 1b).

Figure 1b

Banking to the right



Of the options available for increasing lift, changing the angle of attack is the most practical. Any increase in lift will produce a corresponding increase in drag, and therefore, a reduction in airspeed. In the medium level turn, the lift and drag increases are very slight and the decrease in airspeed is minor – only subtle elevator application may be necessary.

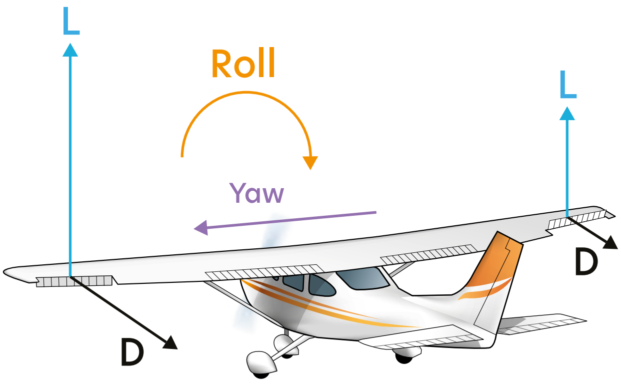
Adverse yaw

From the **Effects of controls** lesson, the student knows that ailerons are used to bank an aeroplane, and this is achieved by changing the shape (camber) of the wing, which in turn changes the lift on that wing. In order to bank right, for example, the left (or up-going) wing has more lift and the right (or down going) wing has less lift.

One of the side-effects of increasing lift is a corresponding increase in drag. So even though there is more lift on the up-going wing, and the aeroplane rolls, there is also more drag on that wing, and that produces a yaw, away from the direction of the turn – termed adverse yaw (see Figure 2).

Figure 2

Yaw away from the direction of the turn



To overcome this effect and to achieve balanced flight, rudder pressure is applied in the direction of turn, while the ailerons are being moved. Once the required bank angle is achieved, and the ailerons centralised, the rudder pressure can be reduced to maintain balance.

The amount of rudder required to overcome adverse yaw is dependent on the rate of roll. For example, during a rapid roll more rudder will be needed than at lower rates. The benefits of differential and Frise ailerons may be discussed.

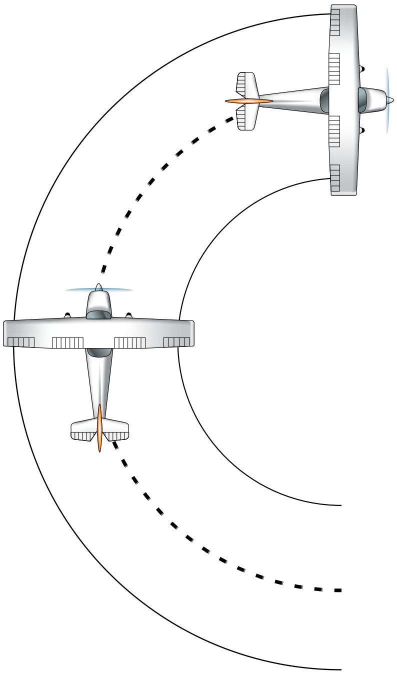
During descending turns, while at low airspeeds, the ailerons will need to be deflected further to achieve the same roll rate as at higher airspeeds. The increased deflection increases the drag, and requires more rudder to overcome the adverse yaw.

Overbanking

Overbanking is the tendency of an aeroplane to want to continue the roll into the turn, or increase the bank angle of its own accord.

Figure 3

Aeroplane wants to continue the roll



In a level turn, the outside wingtip travels further, and therefore faster, than the inside wingtip (see Figure 3). This increase in airspeed results in an increase in lift, which produces a tendency to roll into the turn. Even though this effect is minimal in small training aeroplanes, there will be a tendency for the aeroplane to increase its angle of bank if uncorrected.

For the purpose of this briefing, the increased tendency to overbank in both medium level turns and in climbing turns is caused by the outer wing travelling faster than the inner wing, thereby producing more lift and causing the aeroplane to increase the bank angle. Emphasis must be placed on negating these tendencies by maintaining the required angle of bank with aileron, commonly referred to as **holding off bank**.

In descending turns, the inner wing travels down a steeper descent path and hence meets the relative airflow at a greater angle of attack than the outer wing. The effect is to reduce, neutralise or even reverse the tendency for the bank to increase.

This can be expanded on in a separate briefing if needed.

Performance

As covered in the **Climbing and descending** lesson, excess power determines the rate of climb. When a turn is combined with the climb, the tilting of the lift force and the increase in drag decreases the excess power, and reduces the rate of climb. Therefore, where a requirement to turn and climb exists, and performance is consequently reduced, the angle of bank is commonly limited to 20 degrees, with 15 degrees used for this exercise.

There are no significantly detrimental effects on performance when descending at angles of bank of up to 30 degrees.

Airmanship

Introduce the 20 degree per 2 second visual scan technique. The lookout starts at the tail – by looking over the shoulder opposite to the direction of turn – and continues forward through the nose of the aeroplane in the direction of the turn, to finish looking at the tail again. Discuss the restrictions imposed on a good lookout by the airframe, and therefore the appropriate head movements required to minimise blind spots.

Developing the student's situational awareness is very important. At this stage the lookout, and listen out, are particularly important.

Discuss situational awareness in relation to:

- completing 360 degree turns
- monitoring the aeroplane's position in the training area
- the minimum and maximum altitudes to be used
- the current weather.

Introduce the VFR requirements within controlled airspace. You may like to provide them with a *VFR Met minima* card. You can order these by emailing publications@caa.govt.nz.

Aeroplane management

There are no new engine handling considerations for this exercise, so revise the use of smooth but positive throttle movements.

Revise why carburettor heat may need to be used.

Human factors

Turns are practised through 360 degrees to minimise disorientation. Choose an easily identifiable reference point.

For some students, the sensations of the turn may be uncomfortable at first. They may also tend to lean out of the turn. Let them know that this is a natural human tendency, as the body tries to realign itself with the perceived vertical, and that it will stop with exposure and practice. Students may also feel a slight increase in their weight (G). This is the gyroscopic reaction to the increased lift.

Air exercise

The first exercise will be a demonstration of adverse yaw, emphasising the appropriate use of rudder.

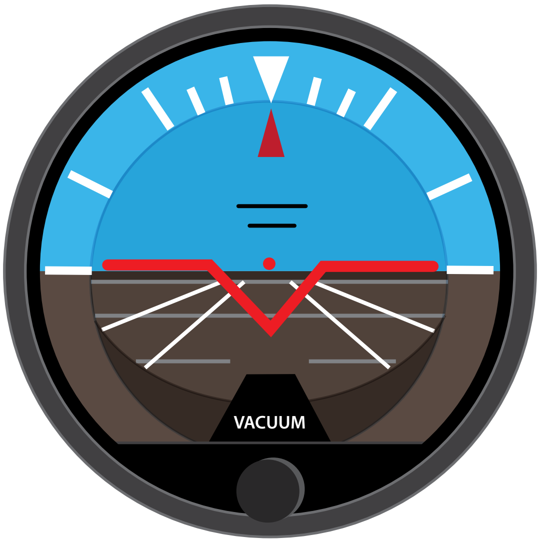
Discuss entering, maintaining, and exiting the medium level turn, at a bank angle of 30 degrees.

The climbing turn is commonly demonstrated at 15 degrees angle of bank and the descending turn at 30 degrees angle of bank.

The markings on the artificial horizon should be explained – at least up to the 30-degree bank angle mark (see Figure 4).

Figure 4

Artificial horizon instrument



Entry

With a reference altitude, prominent reference point chosen, and the heading noted, emphasise and complete a thorough lookout.

Once the lookout is complete, roll the aeroplane smoothly into the turn with aileron and apply sufficient rudder in the same direction to maintain balance. Increase backpressure on the control column as required to maintain the altitude. Emphasise that the increase in backpressure is very slight. For example, if the aeroplane was being flown with the finger and thumb in level flight, only one more finger would be required to maintain the turn.

To maintain a constant airspeed when entering both the climbing and descending turn, relax backpressure as required.

In the turn

At 30 degrees angle of bank – which should be recognised by reference to the attitude and confirmed by instruments – a slight check of aileron will be required and rudder pressure reduced to maintain balance.

Maintaining the turn involves using the **LAI** scan.

L Lookout

In a scan, look out to the left (port) and scan (for a turn to the right) 20 degrees for 2 seconds from left to right, passing over the nose of the aeroplane. Emphasise looking into the turn.

A Attitude

Ensure the attitude for 30 degrees angle of bank and level flight is correct relative to the horizon and, more importantly, constant. When the outside scan is complete, scan inside.

I Instruments

Are scanned to confirm accurate flight (height – bank – ball).

Angle of bank is controlled with aileron – altitude with elevator.

During the turn, scan only those instruments relevant to the manoeuvre and do not trim the aeroplane.

Exit

Lookout into the turn for traffic and the upcoming reference point. Allow for inertia by anticipating the roll out so that the wings will be level when the reference point is reached. Common practice is to use half the bank angle as a guide, for example, in a 30 degree bank, start the roll out 15 degrees before the reference point. This helps establish a smooth roll out, making it easier to coordinate.

Approximately 15 degrees before the reference point is reached, start to smoothly roll wings level with aileron, balance with rudder in the same direction, and relax the backpressure to re-establish the level attitude and maintain a constant altitude. On exit from a climbing or descending turn, check **PAT**.

Airborne sequence

Before flight

The student should be able to taxi by this point. Introduce the instrument check during the taxi, and continue (or begin) to involve the student in the checklists.

You may want to introduce some basic radio work. For example, have the student call ready for take-off, and respond to the clearance (if one is required).

The exercise

The student should be able to perform the take-off following the previous lesson.

On the way out to the training area, revise the different climbing attitudes and their performance.

The student should be capable of climbing to a suitable altitude and levelling off. A short amount of straight and level practice can be done while you talk about adverse yaw. Since it is best to demonstrate adverse yaw at low speed, ask the student to slow the aeroplane down while maintaining straight and level. Take control and demonstrate adverse yaw. There is no need for the student to practise this.

Start with level 30 degree angle of bank turns.

Emphasise the lookout, before and during the turn, by moving your upper body to demonstrate that more than just head movement is required to overcome blind spots.

Rather than patter the entry as "roll in with aileron, balance with rudder", it may be better to patter the actual control movements; for example, "roll in with right aileron, balance with right rudder." You will be able to move to "balanced entry" and "balanced exit" as the student progresses.

Once the student has completed satisfactory medium level turns, both left and right from straight and level, ask the student to enter a climb or descent and demonstrate the attitudes for climbing turns and descending turns. Then the student should enter the climb/descent while turning.

Finish the lesson with the student consolidating what they have learned. Ask the student to climb/descend to an altitude and turn to roll out on a feature, so they can practise coordinating entering the climb/descent while turning and completing the climb/descent while levelling off. The student should complete the manoeuvres at a different altitude and heading from where they started.

On the way back from the training area, more practice at the different descents, and descending turns can be completed. The student may like to use the flap again to become a little more familiar with it.

The student may well be comfortable enough to fly the aeroplane in the circuit, under your direction. Discuss how you will be joining the circuit, and any radio call you need to make.

After flight

Depending on the CFI's lesson sequence, the next lesson may be **Slow flight**, where the student will need to fly straight and level and turn at a slower speed than they have yet seen. Ask them what sort of attitude they would expect to see if they were flying slower than normal.

Encourage them to do some pre-reading before the next lesson.

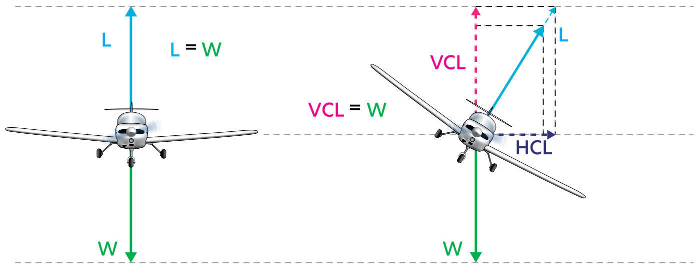
Medium, climbing and descending turns

Objectives

- To change direction through 360 degrees at a constant rate – using 30 degrees angle of bank – while maintaining a constant altitude and keeping the aeroplane in balance.
- To complete a medium turn while climbing and while descending.

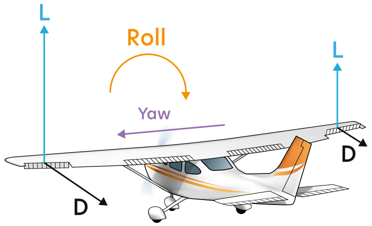
Principles of flight

- In order to turn need to create a force towards the centre of the turn – bank the aeroplane
- HCL provides the force
- VCL reduced \ more L required → increase angle of attack slightly



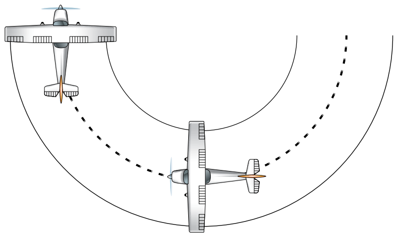
Adverse yaw

- Increased lift on up-going wing also means increased drag, therefore yaw occurs away from turn
- Rudder used to balance yaw as ailerons deflected



Overbanking

- Outer wing travels further, therefore more L, tries to keep rolling
- Hold off bank with aileron



Performance

- When climbing and turning, angle of bank must be reduced maximum of 20°, use 15°

Air exercise

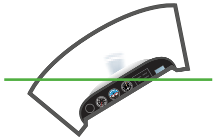
Adverse yaw

- Demonstration only

Entry

Medium level turn

- From S+L
- Lookout
- Roll with aileron to 30° AoB
- Balance with rudder
- Backpressure to set attitude – ↑ slightly

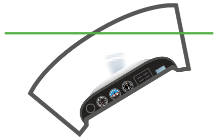


Climbing turn

- Establish in climb
- Lookout
- Roll with aileron to 15° AoB
- Balance with rudder
- Relax backpressure to maintain attitude – ↓

Descending turn

- Establish in glide
- Lookout
- Roll with aileron to 30° AoB
- Balance with rudder
- Relax backpressure to maintain attitude – ↓



In turn

- 'Check' the ailerons and maintain balance
- Lookout
- Attitude
- Instruments
- Angle of bank controlled with aileron
- Altitude controlled with backpressure

Exit

- Look for reference point
- Anticipate rollout by half the angle of bank
- Roll wings level
- Balance with rudder
- Relax backpressure
- Reset S+L attitude
- On exit from a climbing or descending turn, check **PAT**

Airmanship

- 20° per 2 second scan technique
- Lookout and listenout
- SA – 360° turns, position, altitude, weather
- VFR minima, 5-2-1

Aeroplane management

- Smooth and positive throttle movements
- Carb heat

Human factors

- 360° turns to minimise disorientation
- Turning sensation

Slow flight

There are a number of situations when the aeroplane must be flown at or near its minimum airspeed. For example, during takeoff, landing, a go around, or missed approach, and in the stalling lessons.

This lesson is not for operational slow flight, but aims to improve the student's awareness of the characteristics of flight at slow airspeeds and provides practice in maintaining balanced flight at those airspeeds. It's another important coordination exercise, reinforcing the lessons learned during **Straight and level** at varying airspeeds, and is good preparation for the stalling lessons and for the take-off, landing, and go-around phases of circuit training.

The go-around is the most critical of the four phases of flight where we transition through slow flight, for several reasons:

- transition through slow flight is a longer time while close to the ground;
- often the go-around is unplanned or unexpected with potential startle factor;
- configuration could be high-weight and high-drag; and
- management of attaining climb speed and reduction of drag flap is necessary.

Objectives

To slow the aeroplane and maintain straight and level at low airspeed (1.2V_s).

To maintain straight and level at low airspeed in various configurations.

To maintain a constant altitude while turning at low airspeed.

To return to normal operating airspeeds.

Principles of flight

In normal cruise, the angle of attack was approximately 4 degrees and the airspeed _____ knots.

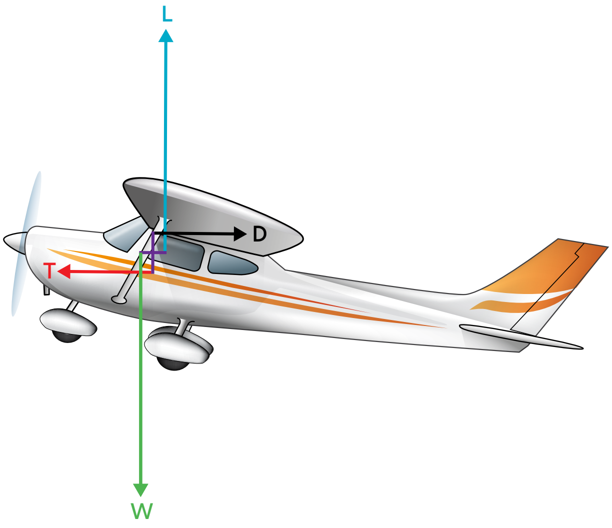
From the **Straight and level** lesson, lift is primarily controlled by varying either angle of attack or airspeed. Lift must equal weight to maintain level flight, so as the airspeed decreases the angle of attack must increase.

Power + Attitude = Performance

In order to fly level at lower than normal airspeed, a higher than normal nose attitude is required, and once at that attitude, a small increase in power is needed to maintain the desired altitude (see Figure 1).

Figure 1

Slow level flight



Revise control effectiveness at slow speeds and the effects of slipstream. The controls will be sluggish and not as responsive as they would be at a higher speed, and the reduced slipstream will require balancing with rudder.

Revise the effect of low airspeeds on control input and response. As seen in the turning lesson, a slower speed produces more adverse yaw.

Airmanship

Revise the 20 degree visual scan technique as introduced in the **Medium, climbing and descending turns** lesson. Take into account the high nose attitude.

HASELL checks are carried out before stalling and aerobatics, and are introduced in this lesson.

H Height (not altitude)

Height not less than 2500 feet above ground level.

Some organisations stipulate a height greater than 2500 feet AGL, consult your CFI.

A Airframe

State the configuration to be used.

S Security

No loose articles, harnesses secure.

There should be no loose articles in the cockpit at any time because of the potential for jammed controls. Explain that harness security is a good aviation practice consideration.

E Engine

Temperatures and pressures normal, mixture rich, check carburettor heat for icing, fuel sufficient and on fullest tank. Fuel pump(s) operated in accordance with operator procedures.

This is a routine systems scan to ensure everything is normal, before and during the exercise.

L Location

Not over a populated area and clear of known traffic areas, including aerodromes.

L Lookout

Carry out a minimum of one 180-degree, or two 90-degree, clearing turns, to ensure other traffic will not result in conflict.

Aeroplane management

The use of smooth but positive throttle and control movements should be stressed. Even though more positive movement of the controls will be required, there is no need to be aggressive with the controls.

Revise why carburettor heat may need to be used.

Be aware that operating at low airspeeds may raise engine operating temperatures.

Consider the position of the aeroplane three dimensionally within the training area.

Consider the warning symptoms of the approaching stall and be constantly aware of the aeroplane's configuration and flight phase.

Human factors

There is a high level of concentration needed in this exercise, so it is quite a demanding lesson.

The high nose attitude will be unfamiliar to the student.

Air exercise

Straight and level at low airspeed

Using the flight manual, determine 1.2V_s.

A reference altitude is nominated and a reference point selected.

Power + Attitude = Performance

P Power

Power is reduced (carburettor heat may be required) to approximately _____ RPM.

The resultant pitch change and yaw must be compensated for. Ensure smooth throttle movements are used.

A Attitude

With the elevator, adjust the attitude to maintain level flight.

The airspeed will decrease gradually. As the airspeed decreases the aeroplane's nose will want to pitch down, requiring subtly increasing back pressure on the control column to maintain the altitude. The wings should be kept level in relation to the horizon, and rudder adjusted to keep straight on the reference point.

Remind the student that during those phases of flight where power and/or airspeed are changing, a change in rudder pressure will be required to maintain balance.

T Trim

Trim promptly and accurately.

Maintain straight and level flight at the nominated airspeed, adjust power as necessary to maintain height and apply the mnemonic **LAI**.

L Lookout

In a scan loop, look out to the left (port) and scan 20 degrees for 2 seconds from left to right, passing over the nose of the aircraft.

A Attitude

Ensure the attitude is correct and, more importantly, constant. When the outside scan is complete, scan inside.

I Instruments

The instruments are scanned to confirm accurate flight.

If a constant altitude is not being maintained, use power as required and adjust attitude to maintain the nominated airspeed.

Power + Attitude = Performance

If the correct level attitude has been selected, the airspeed will be _____ knots (as nominated).

If the correct power setting is maintained, the aeroplane will maintain level flight, and if the wings are level and balance maintained, the aeroplane will remain straight.

Turning at low airspeed

Lift will need to be increased in the turn and this will produce an increase in drag. Power will need to be increased to combat the drag and maintain the nominated airspeed.

Revise adverse yaw from the **Medium, climbing and descending turns** lesson. Adverse yaw is countered with rudder applied in the direction of the roll. Maintain balance.

At low airspeeds, the ailerons will need to be deflected further to achieve the same roll rate as at higher airspeeds. This will significantly increase the induced drag and require more rudder to negate the adverse yaw.

Returning to normal cruise

To regain normal cruise, the mnemonic **PAT** is used. Because of inertia, power leads the sequence to arrest any descent resulting from lowering the attitude.

P Power

Carburettor heat COLD (if applicable), and smoothly increase power to full power.

Correct the resultant yaw with rudder and the pitch up with elevator while…

A Attitude

Gradually lowering the nose and holding level attitude. Maintain wings level with aileron, and balance with rudder (as airspeed increases).

T Trim

Remove obvious loads. When flaps have been raised (if applicable) and normal cruise airspeed achieved, set cruise power, and confirm straight and level is maintained.

LAI – trim accurately to hold the correct attitude.

Airborne sequence

On the ground

Ask the student to do the preflight inspection, and then to come to you afterwards if they have any questions.

Introduce more radio work, and ask the student to call and complete the checklists.

The exercise

The student should be able to complete the take-off by themselves.

On the way out to the training area, there is opportunity to practise climbing and turning.

The student then enters straight and level from the climb and is talked through the **HASELL** checks.

Demonstrate the entry to slow flight at the nominated airspeed and in the nominated configuration – with and without flap. The student should practise after each demonstration.

Demonstrate turning (at up to 20 degrees angle of bank) including reversing the turn direction, followed by student practice.

Allow the student to regain normal cruise, while talking them though the process.

Establish the aeroplane in the approach configuration in a descent at 1.2V_s. State a simulated altitude representing the ground, anticipate by 50 feet, then establish the aeroplane in a climb. This simulates the go-around, emphasising (Effects of controls) the effect of power changes and situational awareness when close to the ground in low speed/high drag configuration.

On the way back to the aerodrome, discuss some more radio calls, and talk them through rejoining the circuit.

After flight

The next lesson will be **Basic stalling**. Ask the student to read up on this.

Provide the student with a copy of the checklists, and ask them to start learning the correct responses for the checklist items. Inform them that you will expect them to know the checklists from memory before they do their first solo flight, and the first step to memorising them is to learn the correct responses.

Slow flight

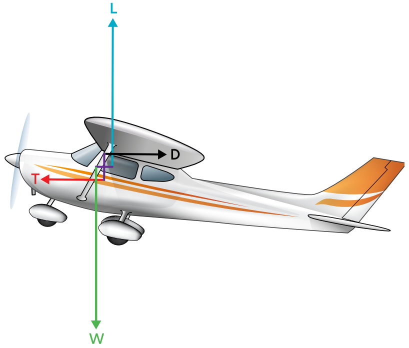
Objectives

- To slow the aeroplane and maintain straight and level at low airspeed (1.2V_S).
- To maintain straight and level at low airspeed in various configurations.
- To maintain a constant altitude while turning at low airspeed.
- To return to normal operating airspeeds.

Principles of flight

Power + Attitude = Performance

- L = angle of attack x airspeed
- As airspeed decreases angle of attack must increase to maintain level
- High nose attitude + little extra power required
- Fly the aeroplane at a slow speed, but above the stall – next lesson
- Less control effectiveness – larger inputs required
- Slipstream effects less – maintain balance
- Medium level turns – need additional power



Airmanship

- 20°/2 second scan
- HASELL checks
- Aeroplane position in training area
- Warning symptoms of approaching stall

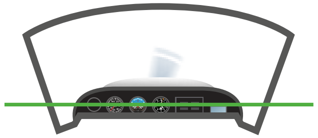
H	Height	Not less than 2500 feet above ground level
A	Airframe	Configuration – clean or flap
S	Security	No loose articles, harnesses secure
E	Engine Ts & Ps	Temperatures and pressures normal, mixture RICH, fuel sufficient and on fullest
L	Locality	Not over a populated area and clear of known traffic areas, including aerodromes
L	Lookout	One 180-degree, or two 90-degree, clearing turns to ensure other traffic will not result in conflict

Air exercise

Power + Attitude = Performance

Slowing to S + L at low airspeed

- Power reduce to decelerate
- Attitude increases as aeroplane slows – maintain level
- Trim to relieve backpressure
- Adjust power to maintain height
- Airspeed = ______



Maintaining S + L at low airspeed

- Lookout
- Attitude
- Instruments

Turning at low airspeed

- To maintain level, Lift must ↑, Drag will ↑, more power required
- Adverse yaw countered with rudder
- Ailerons will need to be deflected more for same roll rate
- Balance with rudder

Returning to cruise

- Power increase to full power, balance with rudder
- Attitude lower nose to level attitude
- Trim to relieve pressure
- Reduce to cruise power, balance with rudder

- Lookout
- Attitude
- Instruments

Aeroplane management

- Smooth but positive throttle and control movements
- Carb heat
- Engine operating temperatures
- Use of flap – power requirements

Human factors

- High level of concentration
- Unfamiliar high nose attitudes

Basic stalling

The **Slow flight** lesson has introduced the student to the practice of flying close to the stall. Here you are furthering their knowledge by showing how the aeroplane behaves when there is not enough lift produced by the wings to balance its weight.

Many new terms and concepts will be introduced to the student during this briefing, and these should be kept as simple as possible.

When an aeroplane stalls, it is not like a car – the engine does not stop. The stall is a breakdown of the smooth airflow over the wing into a turbulent one, resulting in a decrease in lift. The lift will no longer fully support the aeroplane's weight, and the aeroplane sinks.

For the basic stall we keep the aeroplane's configuration as simple as possible, power will be at idle, flap will be up, and if applicable, undercarriage raised.

The student needs to know about stalling for three reasons. The first is to avoid an inadvertent stall. The stall does not just happen – there are many warning signs of its approach, and the student should be familiar with these.

To prevent the inadvertent stall, a pilot needs to be able to recognise the symptoms of an approaching stall, experience it, and then learn the correct recovery technique.

The second reason for being familiar with the stall was highlighted in the last lesson, **Slow flight**. There are a number of times an aeroplane will be operated at a speed close to its stall speed.

The most common of these, and the third reason, is the approach and landing phase of the flight. Every landing is a controlled approach to the stall.

Objectives

To control the aeroplane to the point of stall, recognise the symptoms of the approaching stall, experience the stall itself, and recover with minimum height loss.

Having experienced the stall itself, repeat, only this time recover at stall onset with minimum height loss.

Principles of flight

The basic stall is conducted in a power-idle clean configuration, ie, flap up.

The cause of the breakdown of smooth airflow is the result of the wing being at too high an angle of attack to the airflow.

A model aeroplane may be used to show that aeroplanes do not fly at an angle of attack of 90 degrees to the relative airflow. Therefore, somewhere between straight and level and 90 degrees, a limit is reached at which the air can no longer flow smoothly over the aerofoil.

For the average aerofoil used on general aviation aeroplanes, this limit is reached at an angle of attack of about 15 degrees. It should be emphasised that no matter what speed the aeroplane is flying at, when this angle is exceeded the aeroplane will stall because of the breakdown of the smooth airflow.

One way to do this would be, from straight and level, to close the throttle to idle and attempt to continue flying level.

In straight and level flight the angle of attack was about 4 degrees and the airspeed about ____ knots (see Figure 1a).

As experienced in **Effects of controls**, lift is primarily controlled through angle of attack and airspeed, and lift must equal the aeroplane's weight to maintain level flight. As the airspeed decreases, the angle of attack must be increased to maintain lift equal to weight.

L = angle of attack x airspeed

As the angle of attack increases, the airflow finds it more and more difficult to follow the contoured upper surface of the wing (aerofoil) smoothly, and the point at which the airflow breaks away from the wing, the separation point, moves forward from the trailing edge. At the same time, the point through which lift acts, the centre of pressure (C of P), also moves forward along the chord line; this movement is unstable because it reduces the moment of the lift/weight couple (see Figure 1b).

Figure 1a

Straight and level flight

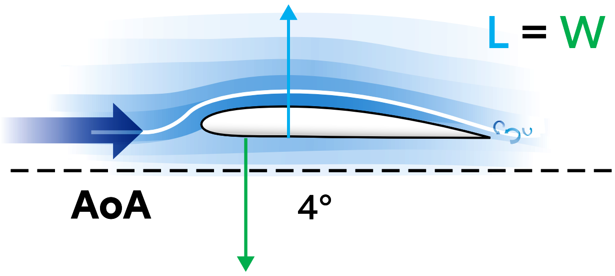


Figure 1b

Increased angle of attack

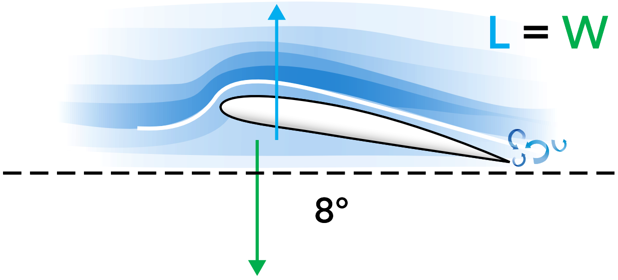
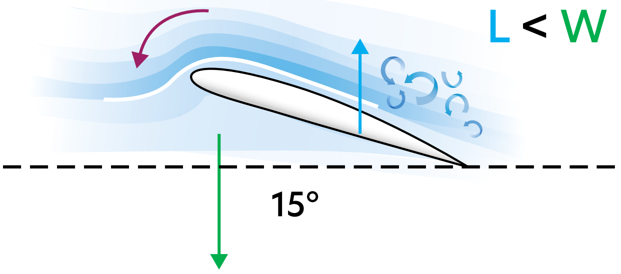


Figure 1c

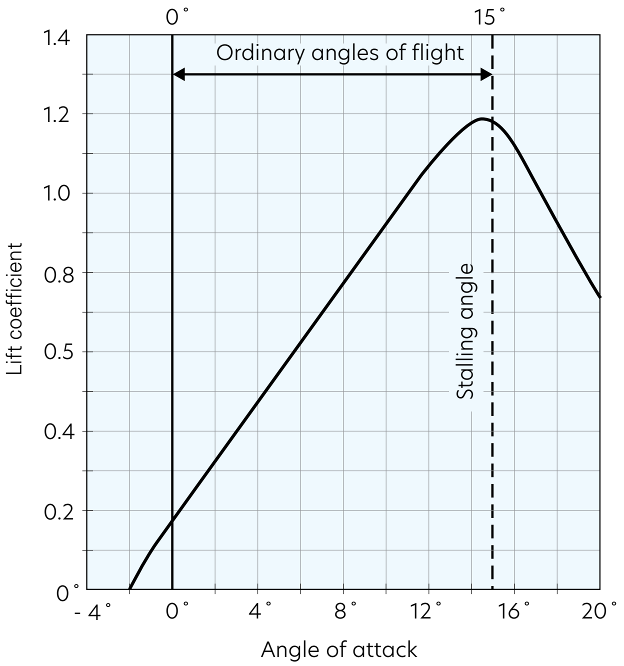
Stalling or critical angle of attack



Eventually, the stalling (or critical) angle of attack is reached, and the inability of the air to flow smoothly over the top surface of the wing results in a decrease in lift and a large increase in drag. This may be illustrated by the lift coefficient versus angle of attack graph (see Figures 1c and 2).

Figure 2

Lift coefficient versus angle of attack



The result is that the aeroplane sinks. At the same time, the centre of pressure moves rapidly rearward. The rearward movement of the centre of pressure increases the moment provided by the lift/weight couple, causing the nose to pitch down – a stable movement.

The factors affecting the stalling speed are discussed in **Advanced stalling**, the emphasis of this briefing is on the cause of the stall – exceeding the critical angle.

Airmanship

Passengers should not be carried during this exercise.

Situational awareness considers not only the position of the aeroplane three dimensionally within the training area, but also the warning symptoms of the approaching stall, and awareness of the flight phase – power set at idle, but attempting to maintain level flight.

Revise the **HASELL** checklist, incorporating those elements particular to stalling. This check is completed before the first stall.

H Height (not altitude)

Height sufficient to recover by not less than 2500 feet above ground level.

The altitude loss should be no more than 300 feet and the recovery height should provide an appropriate environment for practice.

Some organisations stipulate recovery by a height higher than 2500 feet AGL, consult your CFI.

A Airframe

The entry configuration is revised: idle power, flap up.

S Security

No loose articles, harnesses secure.

The basic stall in the modern light aeroplane is very gentle, but it is good aviation practice to secure loose articles to stop them moving around the cabin, and check harness security.

E Engine

Temperatures and pressures normal, mixture rich, fuel sufficient and on fullest tank.

Commonly the electric fuel pump is switched on to guard against an airlock (refer CFI). In addition, the carburettor heat may be cycled to ensure ice has not formed.

L Location

Not over a populated area and clear of known traffic areas, including aerodromes.

Stalling is not carried out over populated areas because large power changes are made throughout the exercise and may disturb people on the ground.

This exercise is not carried out near other aircraft.

L Lookout

Carry out a minimum of one 180-degree, or two 90-degree, clearing turns, to ensure other traffic will not result in conflict.

During the last part of the turn, start looking for a suitable reference point on which to roll out and use for the stall entry.

Introduce the **HELL** checks (a subset of **HASELL**) which are carried out between each subsequent stall.

H Height (not altitude)

Height regained or sufficient to recover by not less than 2500 feet above ground level.

E Engine

Temperatures and pressures normal.

L Location

Not over a populated area and clear of known traffic areas, including airfields.

L Lookout

One 90-degree clearing turn.

Common practice is to make these turns in the one direction (usually left) so that the exercise is carried out in a box over the same ground features. This general practice can be altered to allow for wind direction and strength (drift), the training area boundaries, and other traffic.

Aeroplane management

As large power changes will be made, it is appropriate to revise the requirement for smooth but positive throttle movements and the correct use of carburettor heat.

All preflight inspections should include a search for loose articles. Discreetly ensure a sick bag is available.

Human factors

The regular turns and steeper than normal nose attitudes could lead to a level of disorientation – make sure the student has time between stalls to orientate themselves.

When you teach the stall you will need to gauge the student's level of apprehension and provide appropriate reassurance in a calm professional manner. As the student gains more practice and exposure to stalling, their comfort level will increase, and they should become relaxed about stalling the aeroplane – but never complacent!

The effects of stress are reduced by overlearning the procedure, to produce an initial automatic response, and by experiencing the sensations of the stall, to desensitise the pilot. Tell the student that if they feel uncomfortable at any point, they should say so, the aeroplane can then be flown level, until they feel comfortable to continue.

Air exercise

Entry

HASELL checks are completed and a reference point on which to keep the aeroplane straight is nominated, confirm with the DI. Nominating a reference altitude is a function of the **HASELL/HELL** checks.

Because of the high nose attitude at the stall, choose either a high reference point or have the student sight one along the side of the engine cowling.

From level flight, carburettor heat is selected HOT and the throttle smoothly closed. As the nose will want to yaw and pitch down, keep straight with rudder and hold the altitude with increasing backpressure on the control column.

Through ____ knots, or when the aural stall warning is heard, select carburettor heat COLD, as full power will shortly be reapplied.

Stall warning symptoms

Decreasing airspeed

The first true symptom is a decreasing airspeed. Low airspeed and a high nose attitude are not always present in the approach to the stall. For example, the high-speed stall as a result of pulling out of a dive too sharply. Therefore, although it is desirable to inform the student that a high nose attitude and low airspeed are indicators of an approaching stall for most phases of flight, they will not always be present.

Less effective controls

The next symptom is less effective controls as a result of the lowering airspeed – as they will have experienced in the **Slow flight** lesson. The student should also recognise the progressively increasing stick forces as the stall is approached.

Stall warning device

Reduced control effectiveness is usually followed by the stall-warning device. However, this is not a true symptom, as the device is mechanical and may not work. The type and operation of the stall-warning device fitted to the aeroplane should be described.

Buffet

The last generally noted symptom is the buffet. This is caused by the turbulent airflow from the wings striking the empennage. The effects of buffet are least noticeable in high-wing/low-tailplane aeroplane types, such as Cessnas. This is because the airflow breaking off the high wing combined with the high nose attitude, results in most of the turbulent airflow missing the empennage. Whereas in the low-wing/high-tailplane arrangement, for example the Piper Tomahawk, the turbulent airflow directly strikes the empennage and is very apparent.

At this point, as a result of the low airspeed, elevator effectiveness has been reduced to the point where no further increase in angle of attack can be achieved, even though the control column is held well (or fully) back. This results in the aeroplane sinking and the change in relative airflow causes the critical angle to be exceeded.

The aeroplane stalls, altitude decreases and (generally) the nose pitches down. It is important the student be able to correctly identify when the aeroplane has stalled.

Recovery

The recovery is broken down into two distinct parts: unstalling the aeroplane, and minimising the altitude loss.

To unstall the aeroplane, the angle of attack must be reduced. Even though the aeroplane's nose may have pitched down at the stall, the angle of attack is still high because the aeroplane is sinking. Since increasing the backpressure (or pulling back) increased the angle of attack, decrease the backpressure (or check forward). The 'check forward' with the elevator is a smooth but positive control movement – not a push.

In addition, no aileron should be used; ailerons must be held centralised, for reasons that will be discussed in the briefing **Advanced stalling**. However, the correct use of aileron must be stated right from the beginning in order to get the sequence right first time and every subsequent time.

You should be attempting to introduce stalling in its simplest and most basic form. Therefore, every effort should be made to avoid the wing-drop. If the aeroplane has a known tendency to wing-drop in the basic configuration it may be necessary to explain this tendency and the result, as well as the reason for not using aileron in the recovery (refer CFI).

If an explanation is required, keep it as simple as possible at this level. For example, "For various reasons one wing may stall before the other and this will produce a roll; ignore the roll (no aileron, aileron central, aileron neutral) and simply check forward."

Your choice of terms – check forward, relax backpressure, ailerons neutral, no aileron, or ailerons central – should match your airborne patter.

It should be made clear that reducing the angle of attack is all that is needed to unstall the aeroplane. The aeroplane will enter a descent, and the student can now regain straight and level from the descent (**PAT**). The altitude loss will be about 300 feet using this method, and will be the first recovery method the student practises.

However, **to minimise the altitude loss** – **Power + Attitude = Performance**.

For the least loss of altitude, the maximum amount of power is required (hence carburettor heat COLD during the entry) so smoothly but positively apply full power (prevent yaw – keep straight) and raise the nose smoothly to the horizon. There is no need to hold the nose down, as excessive altitude will be lost. Similarly increasing backpressure too rapidly, or jerking, may cause a secondary stall.

Nose-on-the-horizon may be used as the reference attitude. Of the attitudes the student is familiar with the level attitude is too low and the aeroplane will continue to sink, resulting in unnecessary altitude loss. Alternatively, the climb attitude is too high, as the pitch-up created by full power combined with inertia may result in a secondary stall. In addition, the student should be discouraged from thinking that pulling back will make the aeroplane stop sinking – that's how the stall was entered.

A compromise attitude is required to arrest the sink and allow the aeroplane to accelerate to the nominated climb speed. The simplest attitude to use is to put the top of the nose cowling just on the horizon. For some light aeroplanes this attitude is the same or similar to the climb attitude, but at least the student has not been encouraged to try to climb by simply pointing the aeroplane upwards.

The expected altitude loss should be stated, for example, not more than 100 feet.

The aeroplane should be held in the nose-on-the-horizon attitude until the nominated climb speed is reached and then the climb attitude selected.

Common practice is to use the recommended or normal climb speed, for example 70 knots. However, you may nominate speed for best angle of climb or for best rate of climb (refer CFI).

Straight and level flight should be resumed at the starting altitude and the reference point or heading regained if necessary.

Recovery at onset

All stalling exercises should finish with a recovery at the incipient stage, more commonly referred to as the onset. This is to emphasise that, under normal conditions of flight, the stall is avoided.

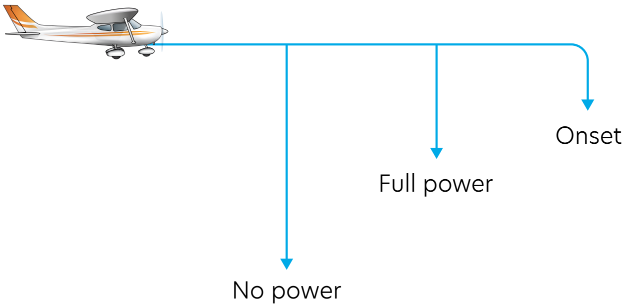
The second objective of this exercise is to recover at onset, which means at the stall warning or buffet.

The stall itself is simply the stall and is sometimes referred to as fully developed, meaning that the stall has occurred. A fully developed stall does not imply a wing-drop.

The expected altitude loss from a recovery at onset (depending on which symptom is first detected) should be stated, for example, less than 50 feet. With practice and improved situational awareness, this altitude loss can be reduced to zero – as the aeroplane is not permitted to stall (see Figure 3).

Figure 3

Recovery at onset of the stall



Airborne sequence

On the ground

Make sure the preflight inspection identifies any loose objects and they are secured.

Encourage the student to take on more of the radio work, and to start their study for the radiotelephony exam.

Run through the checklists with the student, checking that they are learning the responses.

The exercise

On the way out to the training area there is opportunity to practise climbing, straight and level and turning.

Demonstration

When setting the aeroplane up and choosing a reference point choose one into or with the wind to reduce any problems the student might have with drift perception.

Start with a demonstration of the basic stall and recovery, rather than the recovery at onset. Although the student is being taught to avoid the stall, they still need to experience what it is they are trying to avoid. During the demonstration the student should be advised to observe the high nose attitude, and asked to identify the actual stall so both instructor and student know they recognise the same thing.

In line with the objective of recognising the symptoms that warn of an approaching stall, the next step is to carefully demonstrate the symptoms.

The entry is pattered as "reference point, reference altitude, carburettor heat HOT, reduce power, keep straight and wings level." Remind the student to look outside at the reference point to keep the wings level with aileron and straight with rudder – just a glance at the balance ball is all that is required.

From this point on, you can adjust the amount of backpressure to synchronise your patter to match the symptoms. For example, with practice you will be able to synchronise the words "and the stall warning sounds like [pause] that."

The aeroplane can be held in the stall to demonstrate the buffet and the sink if required.

At the stall, the nose-down pitch is observed and identified by the student, and the normal recovery carried out by you without patter.

If the sink was discussed in the air exercise, this can be demonstrated only from a level entry. It is difficult to detect and may register as a ROD on the VSI, even though the elevator is held well or fully back, before the nose pitches down. The decision to include this demonstration depends on whether or not it was discussed in the air exercise, the aeroplane type, and ultimately the CFI.

Once the symptoms have been carefully demonstrated there is no need to rattle them off during every stall entry. Your patter can now be directed at the recovery.

Patter and follow through

The entry and recovery without power is pattered with the student following through. In addition, the student is given the opportunity to carry out the entry and recovery without power because this is the simplest recovery, and because checking forward centrally, when the nose is pitching down is not a natural reaction – but must be made through a conscious decision.

With the aeroplane in a glide descent the student can be asked to put the aeroplane into either straight and level flight (**PAT**) or directly into a climb (refer CFI) and the altitude loss noted.

Minimising the altitude loss is covered next. This requires the application of full power earlier than the previous student practice, and smoothly raising the nose to the horizon until the nominated climb speed is reached while stopping yaw with rudder.

If the benefits of power in reducing the altitude loss are to be seen clearly, you must ensure that during the demonstrations accurate altitude holding is maintained throughout the entry.

Talk through

From this point the student is talked through and can practise. Remember, for this lesson, the correct recovery sequence of events is more important than speed or coordination of execution.

At the end of the airborne sequence, a recovery at onset should be carried out by the student. Common practice is to nominate a symptom at which the recovery will be initiated. For example, 60 knots, stall warning, or buffet (if the latter is easily detected).

If the student has practised slow flight and can recognise the symptoms leading up to the stall, they should be able to fly the aeroplane slowly and avoid an inadvertent stall.

This is an appropriate time to demonstrate a stall with power and flap (see the **Advanced stalling** lesson). Here, this manoeuvre is placed after the circuit lessons, but refer to your CFI for the point at which your organisation teaches it. If the Advanced stalling lesson is to be delayed until after the circuits, the student will benefit from seeing a stall with power and flap demonstrated before they undertake circuit training. It is important the student understands the recovery technique still requires a reduction in the angle of attack by checking forward.

On the way back to the aerodrome they can practise more straight and level flight, particularly concentrating on prompt and accurate trimming. As well as turning and descending, the student should be talked through the circuit and as much of the approach as you think they are capable of.

After flight

Debrief the student and remind them that there will be lots of opportunity to practise stalling, but the primary objective is to be able to recognise the stall and avoid the inadvertent stall.

Encourage the student to continue learning the checklists.

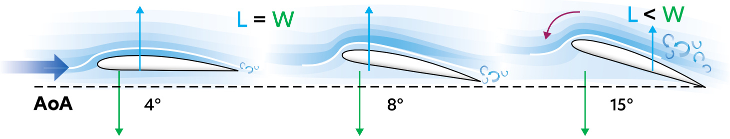
Basic stalling

Objectives

- To control the aeroplane to the point of stall, recognise the symptoms of the approaching stall, experience the stall itself, and recover with minimum height loss.
- To control the aeroplane to the point of stall, recognise the symptoms of the approaching stall, and recover at stall onset with minimum altitude loss.

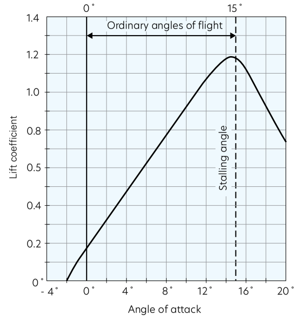
Principles of flight

- L = angle of attack x airspeed
- Smooth airflow over the wing breaks down and becomes turbulent
- Breaks away from upper surface, aeroplane sinks, nose pitches down



At the stall

- When the wing stalls there is a ↓ in L and large ↑ in D
- Aeroplane sinks, C of P moves rearwards → pitch down



Airmanship

- No pax
- Awareness of aircraft configuration, position and other traffic
- HASELL checks
- HELL checks
- Recognise symptoms

H	Height
A	Airframe
S	Security
E	Engine Ts & Ps
L	Locality
L	Lookout

Air exercise

Entry

- HASELL checks and reference point (high)
- Carb heat HOT
- Close throttle
- Keep straight with rudder
- Maintain altitude with ↑ backpressure
- Through ________ kts (or stall warning sounds), carb heat COLD

Symptoms

- Low and ↓ airspeed
- High nose attitude
- Less effective controls – higher stick forces
- Stall warning – if fitted
- Buffet (turbulent air from wing striking tailplane)
- Control column will be fully back – no further control movement

At the stall

- Aeroplane sinks and nose pitches down

Recovery

To unstall

- Check forward with control column to reduce angle of attack
- Do not use ailerons
- Aeroplane will descend
- Recover to S+L with **PAT**

To minimise height loss – max of 100′

- **Power + Attitude = Performance**
- Unstall, as above, check forward
- Apply full power – balance with rudder
- Raise nose to the horizon (stops sink and allows acceleration)
- Accelerate to ________ kt, then adjust attitude to maintain speed
- Regain starting altitude and S+L

Recovery at onset

- Normal situation – when not training
- Recover at stall warning / buffet
- Height loss – 50 ft maximum

Aeroplane management

- Smooth but positive throttle and control movements
- Preflight – no loose objects
- Carb heat use

Human factors

- More practice and exposure the better
- Plenty of time between stalls to orientate
- Sick bags

Circuit training

The order for the following eight lessons will be dictated by the conditions on the day, the student's ability to learn the new material, and their progress in mastering the skills.

Please refer to your CFI for the order your organisation uses.

Circuit introduction

The circuit is an orderly pattern used to position the aeroplane for landing and minimise the risk of collision with other aircraft.

Aerodromes attract aircraft, therefore rules and procedures are required to maintain an orderly sequence or flow of traffic. Knowing that all aircraft should be following these published procedures makes it easier to identify which runway should be used, where other aircraft are (or can be expected to be), and who has the right of way (or priority) in the sequence to take-off or land.

Having the right of way does not absolve the pilot-in-command from avoiding a collision.

The standard circuit pattern or procedure, and the rules to be employed around specific aerodromes, are published in *AIP New Zealand*. The rules governing circuit procedures are contained in Part 91, Subpart C.

The skills the student has acquired leading up to this lesson combine so that there is only one new skill to be learned now – landing the aeroplane.

This briefing is based on the normal left-hand circuit, assuming nil wind or at least wind straight down the runway, with variations to this gradually introduced. Aim to introduce this lesson under ideal conditions. Obviously, this will not always be possible, and the briefing will need to be modified for the actual conditions on the day. In addition, discuss with your supervisor or CFI the acceptable weather conditions for this lesson.

Objectives

To take-off and follow published procedures that conform to the aerodrome traffic circuit, avoiding conflict with other aircraft.

To carry out an approach and landing using the most suitable runway.

Considerations

Take-off

Even though the student will probably have completed a number of take-offs already, this is an important review of what they know. The lesson also introduces some new considerations and establishes the standard.

Slipstream

In aeroplanes where the propeller rotates clockwise, when viewed from the cabin, the effect of slipstream is to apply a force on the port side of the vertical tail fin, and this will tend to yaw the aeroplane to the left at high power settings. This effect is greatest during the take-off roll as a result of the high power and low airspeed.

Torque

The effect of torque, the force that tries to rotate the aeroplane rather than the propeller, is to cause increased downward pressure to be applied to the left main wheel. This results in increased resistance on this wheel, yawing the aeroplane to the left.

There are two more effects, but these apply more significantly to tailwheel aeroplanes.

Asymmetric blade effect

Asymmetric blade effect is the result of the down-going blade of the propeller meeting the relative airflow at a higher angle of attack than the up-going blade. This effect is noticeable with tailwheel aeroplanes; it will only affect tricycle types in the rotate or climb. It results in the thrust force being slightly offset to the right (in clockwise rotating engines, as viewed by the pilot) and thus a tendency to yaw to the left.

Gyroscopic effect

The gyroscopic effect occurs when the tail is raised to the level attitude. This causes a force to be applied to the propeller disc, the effect of which will be to produce a turning moment, which acts at 90 degrees in the direction of propeller rotation. Gyroscopic effect has no practical application to tricycle types.

Keeping straight

Emphasise that rudder should be used as required to keep the aeroplane straight during the take-off roll by reference to a feature at the far end of the runway, and if available, the runway centreline. Whenever power is changed, the aeroplane will yaw, and this must be corrected with rudder.

Crosswind

The tendency for the aeroplane to weathercock (point nose into wind) during the ground roll or while taxiing, as a result of a crosswind pushing on the empennage is explained, and the need to keep straight on the reference point is restated. In the air, allowance for drift is necessary to track towards any reference point.

Headwind

The presence of a headwind reduces the length of the ground roll and in an extreme example, if the aeroplane was parked facing into wind, and the wind was blowing at ____ knots, the aeroplane would be about to get airborne, and they sometimes do in strong winds if not tied down well.

There will be no drift experienced if the wind is directly ahead of the aeroplane, and there is no crosswind component.

Tailwind

A take-off with the wind would require the aeroplane to be accelerated to the wind speed just to bring the airflow over the wing to a standstill, a further ____ knots would be required to get airborne, greatly increasing the take-off distance required. For example, just 5 knots of tailwind increases take-off distance by 30 percent.

Taking off with a tailwind results in a shallow angle of climb, reducing obstacle clearance.

Climb angle

If the wind was blowing at 70 knots and the aeroplane was in a 70-knot climb, to a ground observer the aeroplane would appear to rise like an elevator, as the distance travelled forward over the ground would be zero. Therefore, the angle of climb is increased (ie, is steeper) into wind, improving obstacle clearance.

Take-off into wind

For the above reasons, all take-offs are into wind, to minimise the ground roll and take-off distance, and to improve the climb angle.

Ground roll =
brake release to lift off

Take-off distance =
distance taken to achieve
height of 50 feet

both are
affected

Power

Use full power to minimise the take-off roll and ensure climb performance.

Flap

Flap increases lift and drag. Because of the drag increase, most light aeroplane Flight Manuals do not recommend the use of flap for a normal take-off, although this will depend upon the runway surface.

Surface and slope

Discuss factors that are applicable to the runway being used.

Landing

Wind

Landing into wind reduces the groundspeed, requiring less stopping distance and therefore a shorter landing distance and ground roll.

Ground roll =
wheels-on-the-ground distance

Landing distance =
from 50 feet above
threshold to full stop

both are
affected

Once again, if the headwind is 70 knots the aeroplane would not need to move forward at all to descend at 70 knots. Therefore, a headwind steepens the approach and improves obstacle clearance.

Flap

Flap increases lift and drag. The increased lift lowers the stall speed and permits a lower and safer landing speed, which will also reduce the ground roll. The increased drag allows a lower nose attitude for the same airspeed, and it increases the rate of descent, steepening the approach which provides improved forward visibility and obstacle clearance.

Power

Power controls the height or rate of descent. As discussed in the **Climbing and descending** lesson, increasing or decreasing the power alters the rate of descent.

The increased rate of descent as a result of using flap is countered by the use of power to control the rate of descent. In addition, the use of power provides a slipstream effect that makes the rudder and, more significantly, the elevator more effective. Therefore, in a modern light aeroplane the normal approach is a powered approach using full flap. The various reasons for limiting flap during the approach will be discussed under the non-normal circuits.

Brakes

Brakes will need to be used to either slow the aeroplane or bring it to a stop. If carrying out a touch and go, brakes will not be used.

It is very important that you discuss the need for the student to keep their feet off the toe brakes to avoid inadvertent use of the brakes during take-off or landing.

Runway length

The student should be left in no doubt that sufficient runway length for take-off and landing must be available before starting the take-off or approach.

At this point, you can tell the student that you have carried out the necessary calculations. However, before the third or fourth (refer CFI) revision exercise of circuits, a formal briefing or discussion of the Group Rating System and its application must be given. Before the fifth or sixth (refer CFI) revision of circuits, the calculation of take-off distance by reference to the Flight Manual must be carried out.

The effects of density altitude, weight, surface and slope are discussed during circuit revision when discussing calculation of required take-off and landing distances. Therefore, they need not be formally introduced in this briefing, unless any are pertinent to your normal circuit (refer CFI). The effect of these factors will be revised (not taught) during the briefing Short field take-offs and landing.

Windshear

The effects of windshear may be discussed in this briefing (refer CFI) or incorporated in the second lesson on circuits.

Airmanship

Throughout circuit training, you should place more and more emphasis on the student's command decision making.

Checklists

Checklists, as well as the use of a kneepad to record ATIS (Automatic Terminal Information Service) information, fuel endurance, and clearances, will assist in the retention and processing of information.

It is well known that humans are limited in their ability to recall information accurately from memory. The use of written checklists for normal and emergency operations is reasonably common in general aviation. However, basic flight training still tends to use mnemonics exclusively for all operations. What is learned first is generally accepted as being the correct method, therefore, the use of checklists should be encouraged during basic training.

There are two ways to use a checklist. It can be a list of things to do, as used with complex aeroplanes or systems, or a list to check off things that have been done, as used with simple aeroplanes or systems. General aviation basic training tends to use mnemonics to complete the checks, while confirming that checks have been completed by using a written checklist.

Correct use of the aeroplane radio and checklists will influence situational awareness.

Right-of-way rules

As there will be several preflight briefings during circuit revision, the right-of-way rules can be spread over these briefings.

The suggested rules for discussion in this briefing are:

- aircraft taking off and landing have right of way over all other traffic,
- aircraft landing have right of way over aircraft taking off,
- aircraft established in the circuit have right of way over joining traffic,
- the good aviation practice considerations of avoiding overtaking or cutting in, and
- the application of the right of way rules while taxiing.

The rules or good aviation practice considerations most pertinent to your operation should be considered first. For example, circuit direction and altitude.

Aeroplane management

The importance of normal instrument readings is revised.

SADIE checks are introduced.

S Suction

Suction gauge is operating in the green range.

A Amps or Alternator

Ammeter or alternator is functioning correctly.

D Direction indicator (DI)

DI has been synchronised to the compass and is functioning correctly.

I Ice

The existence of carburettor ice has been checked for, and carburettor heat applied if required.

E Engine

Engine temperatures and pressures are in the green range.

Human factors

Good communication (radio, ATIS), preflight/in-flight planning and regular practise will minimise disorientation. In addition the student should be asked to describe the wind direction and strength to help orientate them.

Visual landing cues should be introduced in this lesson, and the various aspects of visual limitations previously discussed should be revised.

During circuit training there is a possibility the student may reach a learning plateau, where progress may appear to be minimal, discuss this with your student if it happens to them.

On the downwind leg, although the physical eye height of students will vary, the effect on the judgement of spacing will be negligible. However, your perspective from the right-hand seat may be noticeably different and must be compensated for, as it is what the student sees that is important.

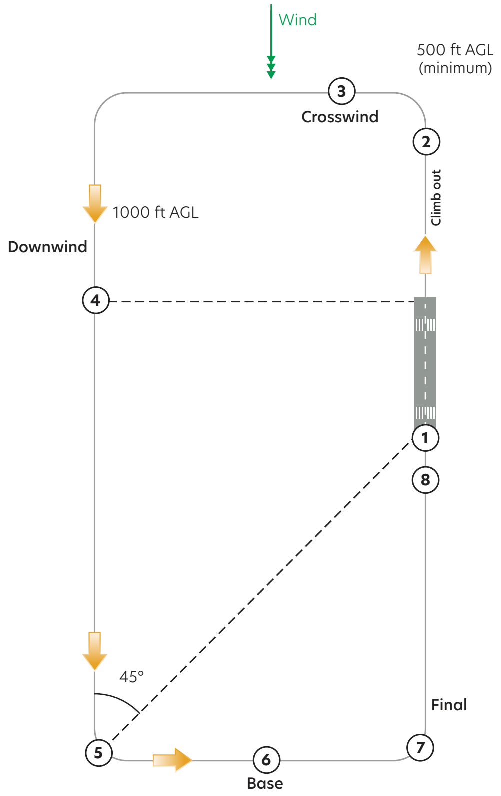
Air exercise

One method you may like to use, is to draw the circuit pattern (see Figure 1) and number and identify the various points around the circuit at which the listed actions are carried out.

Since each lesson leading up to the circuit involved one or more legs of the circuit, this lesson is primarily revision and application, with emphasis on the new material – the landing.

Figure 1

Circuit pattern



① Take-off

Only the main points are revised, for example, reference points, keeping straight and rotate speed if applicable, as the student will probably be doing the take-off by now.

Two reference points should be chosen on lining up (backed up by the DI), one at the far end of the runway on which to keep straight during the take-off roll, and one higher up to keep straight on during the climb.

This second reference point may need to be modified if a crosswind is present, to prevent drift and provide a straight track over the ground along the extended centreline.

On lining up, the aeroplane should be allowed to roll forward a short distance on the centreline to ensure the nosewheel is straight and aligned with the centreline.

Once on the runway, the aeroplane is held on the foot brakes (if required), never on the park brake. When taxiing, forgetting to release the park brake is easily and rapidly identified, however, with the application of full power for take-off, the poor acceleration may not be recognised early enough.

In aeroplanes fitted with only a hand-operated brake, if the brake is applied once on the runway, the hand applying it should not be removed until the brake is released.

Early in the take-off roll, with full power applied, temperatures, pressures, RPM and airspeed should be checked for normal readings.

During the normal take-off, the aeroplane is seldom actually rotated. Common practice is to use elevator backpressure to take the weight off the nosewheel as the aeroplane accelerates. The aim is to reduce the loads on the nosewheel (the undercarriage weak link) and reduce friction. As the aeroplane continues to accelerate it will fly off in a slightly nose-high attitude and rapidly accelerate to the nominated climb speed.

'Rotate' generally refers to rotating the aeroplane about its main wheel axles into a nose-high attitude to increase the angle of attack and lift the aeroplane off the ground. Commonly, this is done at a speed just above the stall speed (about 5 to 10 knots above). The aim of this procedure is to minimise the retarding effects of the ground roll, and is often used on soft surfaces or on runways of minimum length. There may, however, be an appreciable delay in accelerating to climb speed.

Maintain the appropriate pitch attitude until reaching the nominated climb speed, and then hold the climb attitude and trim.

② Climb out

Each leg of the circuit is named and explained. The first leg – climb out – is the leg on which separation from other aircraft in the circuit is achieved. This is because the aeroplane groundspeed is at a minimum while climbing into wind, and therefore the circuit pattern is minimally distorted. The practice of trying to provide adequate separation from aircraft ahead during the downwind leg, where the groundspeed is at a maximum, should be discouraged as this tends to unnecessarily stretch out a busy circuit. Therefore, although a climbing turn onto crosswind may be started at 500 feet AGL, the actual height at which the turn is started will be dictated by traffic ahead.

Where no conflict with traffic ahead is anticipated, the turn should be started at 500 feet AGL – this will assist any following aircraft. Ensure an appropriate lookout is conducted, and reference point identified.

During the climb out and at a safe height, not less than 300 feet AGL, the after take-off checks are completed. A check is made (glance back) to confirm whether the chosen high reference point is maintaining the aeroplane along the extended centreline. If not, an adjustment to the chosen reference point is made.

If flap is used, retraction heights and speeds need to be discussed.

At night, runway heading (DI) is maintained to avoid spatial disorientation.

③ Crosswind

The crosswind leg is at 90 degrees to the climb out path and in the circuit direction. Before starting the turn, lookout is stressed and you chose a reference point to turn onto.

Commonly, this is a point on the horizon off the wingtip. However, since the aim is to track over the ground at right angles to the runway, the reference point will need to be modified to allow for drift.

④ Downwind

For many situations the turn onto downwind is made when the aeroplane is at 45 degrees to the upwind threshold, onto a suitable reference point so as to track parallel to the runway, and the aeroplane is levelled at circuit altitude. This may require the aeroplane to be levelled before, during or after the turn onto downwind.

Lookout is again stressed, especially for aircraft joining the circuit on the downwind leg.

The downwind radio call is given abeam the upwind end of the runway to positively establish your position in the circuit for other traffic, and Air Traffic Control (ATC) if applicable. If the radio call is delayed for any reason until abeam the threshold, or later, the call should be “late downwind”. As a common courtesy, and to promote situational awareness for all traffic in the circuit, the downwind call should include your intentions, for example, full stop or touch and go. If your position in the circuit is advised by ATC, for example, “number three”, a visual search must be made to positively identify the positions of the appropriate number of aircraft ahead. This is generally achieved by scanning from the threshold back along the approach path and base leg, counting off aircraft sighted ahead of you.

Checklists

The attempt to standardise checklists across aeroplane types may result in irrelevant checks becoming so automatic that they are not actually carried out when required. Latent errors do exist within checklists, and it is recommended that the normal checklist be type specific and backed up by a written checklist (refer CFI).

Thus the use of BUMFH is considered irrelevant for fixed-undercarriage types and generally wrong for retractable types. Most aeroplanes with retractable gear require the undercarriage to be extended before the brakes can be checked for pressure. So the mnemonic should be UBMFH when flying aeroplanes with retractable undercarriage.

The prelanding checks are completed.

U Undercarriage

Undercarriage is down and locked (If your organisation includes it at this stage for consistency with later training.)

B Brakes

Brake pressure checked, and park brake off

M Mixture

Mixture set to RICH

F Fuel

Set to the fullest tank, fuel pump ON and pressure checked

H Harnesses and Hatches

Secure harnesses and doors or canopy closed

Spacing

To judge spacing, a feature of the airframe is assessed against the runway; for example, in most low-wing aeroplanes the correct spacing is achieved when the wingtip runs down the centreline, as observed by the student. In the PA 38, which has very long wings, the outboard flow strip is used, and in high wing aeroplanes the spacing is normally one third of the way down the wing strut from the tie-down end. This can be difficult for the student to see, and there may be some value in marking the strut with tape or a felt-tip pen at the approximate position on the strut through which the runway should cut.

The spacing should be assessed and then corrected at the base turn, allowing for any drift. Do not weave downwind in an effort to correct the spacing. The reference point may be altered in order to maintain a parallel track to the runway. In nil wind the DI should show the reciprocal of the runway in use.

⑤ Base turn

The turn onto base starts at approximately 45 degrees to the threshold. Emphasise the lookout and choose a reference point off the wingtip. Carburettor heat is selected ON, power reduced and a level turn started to bring the airspeed into the white arc. Once in the white arc, 10–20 degrees of flap is selected and, as the airspeed approaches the nominated descent speed, the correct descent attitude is selected, held and trimmed.

The power setting chosen at the base turn depends on the assessment of the downwind spacing (close, correct or wide) and the proximity to 45 degrees from the threshold when starting the turn (early, correct, late). Commonly, 1500 RPM is used as a guide, and this is based on the correct spacing downwind and 45 degrees to the threshold. Any other condition will require a higher or lower power setting. For example, close downwind but correct at 45 degrees, try a lower power setting, say 1300 RPM.

The turn is continued onto the reference point with an allowance for drift or until the leading edge of the wing or wing strut is parallel with the runway (allowing for drift).

Avoid using ground features as turning reference points as this may cause difficulty for the student at an unfamiliar aerodrome.

⑥ Base leg

Once established on base leg, additional flap (type depending) can be extended, and the attitude adjusted to maintain the nominated approach airspeed.

At the base turn, the student should be encouraged to estimate what power setting they would require, to take them to the threshold in a steady descent without any changes. This does not mean that the power setting should not be altered if required.

Before the descending turn onto final, emphasise the lookout, especially along the approach path to ensure no other aircraft are on long final. The roll out onto final, or approach leg, must be anticipated so that the wings are level at the same time as the aeroplane is aligned with the centreline. Throughout the turn the angle of bank should be adjusted to achieve this by about 500 feet AGL. The nominated approach airspeed should be maintained by adjusting attitude.

During the approach, as with all phases of flight where the intent is to maintain a specific airspeed, it is important to emphasise that the correct attitude, for the desired airspeed, should be selected, held and trimmed.

Attitude controls the airspeed

⑦ Final

When established on final, full flap is selected at the appropriate time and the airspeed maintained, or allowed to decrease to threshold crossing airspeed through attitude adjustment (refer Flight Manual and CFI).

Because of the possibility of large flap deflections and the aeroplane's low altitude, extending flap during the turn onto final is avoided.

The approach path is monitored by reference to the correct runway perspective (see Figure 2). Throughout the descent the aiming point, commonly the runway numbers or threshold, is monitored and the power adjusted as required to maintain a steady rate of descent to touchdown.

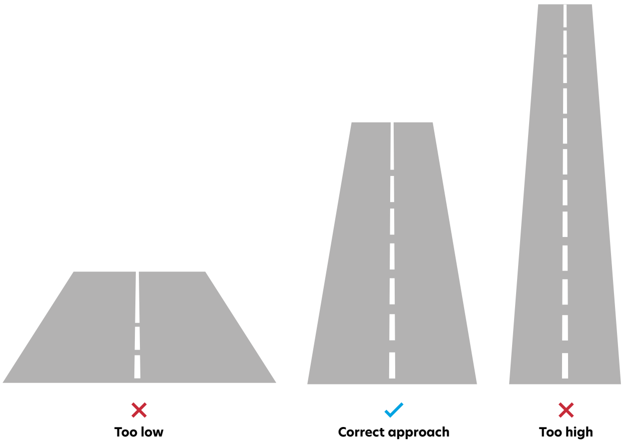
Power controls the rate of descent

With the aeroplane trimmed to maintain the required attitude (airspeed), if the aiming point moves up the windscreen, the aeroplane is undershooting – increase power. If the aim point moves down the windscreen, the aeroplane is overshooting – decrease power. If the aeroplane is correctly trimmed the power adjustments will be quite small; these are often described by the term "a trickle of power".

On short final in anticipation of any requirement for full power, carburettor heat is selected COLD when a landing is assured.

Figure 2

Runway perspective on approach



⑧ Landing

The landing is one smooth manoeuvre designed to slow the rate of descent to zero and the speed to just above the stall speed, as the wheels touch the ground. This manoeuvre consists of two phases, the round-out and the hold-off, also known as the flare. This is essentially a progressive transition from a descent into a flared landing attitude, similar to a power-off stall, with touchdown just before the moment of stall.

The round-out begins at a suitable altitude for the aeroplane's speed. For a normal approach, this is described as about 50 feet.

When the landing is assured, often pattered as "crossing the fence", the throttle is closed, and at about 50 feet the nose attitude progressively raised – the round-out. As the airspeed decreases the aeroplane will start to sink. The sink is observed by looking outside at the far end of the runway (or horizon) and this is the point where the second phase of the landing process begins. The most common errors made by students during the round-out is not looking far enough ahead and lowering the nose in an attempt to fly down to the ground.

The hold-off involves a gradual increase in backpressure to control the rate of sink and to achieve the correct attitude so that the touchdown is light and on the main wheels only. During this phase, the student's focus is gradually shortened to facilitate depth perception and provide cues about the sink rate until, at touchdown, the point of focus is just ahead and slightly left of the aeroplane's nose.

Following touchdown on the main wheels, the nosewheel should be gently lowered with elevator by relaxing the backpressure and lowering the nose onto the runway.

Keep straight on the runway centreline with rudder by reference to a point at the far end of the runway, and apply brakes as required.

Under ideal conditions, during the student's introduction to the circuit, each circuit is flown to a full stop and the aeroplane taxied to the holding point for another take-off. Therefore, the considerations of a touch and go and the go-around are deferred to the next circuit lesson, **Circuit considerations**.

Although including the go-around in this briefing can generally be deferred, it is not always convenient in a busy circuit to carry out full stop landings. Therefore, a brief discussion on the touch and go procedure may need to be included in this briefing (refer CFI).

Should a go-around be required during this introductory exercise, it is recommended that you take control and patter the procedure.

The after-landing checks are normally completed clear of the runway.

Air exercise

On the ground

The student should be capable of taxiing to the appropriate holding point and carrying out at least some of the checks and using the checklist. Complete the take-off safety (or emergency) brief for the student, inform them that you will cover this in a future lesson, and then you will be asking them to do their own.

The exercise

Start by giving a demonstration of an ideal circuit, followed by pattering the student through a circuit.

The student should be able to fly almost all of this exercise, but will probably still need help with the landing. Let them fly as much as possible – they will only learn by doing, and they need to be doing it consistently for themselves before they can go solo.

You will need to talk them through most of this exercise, but as the circuit lessons progress, you will find yourself saying less and less.

After flight

Reassure the student that even though there seems to be a lot to fit into the circuit there will be plenty of opportunities to get it right, as all of the following lessons to first solo will be in the circuit.

Encourage them to continue learning the ground checks, and to start learning the prelanding checks.

During circuit revision, your supervisor will regularly fly with your student to monitor the student's progress and provide feedback on your instruction. This does not prevent you from carrying out a briefing or discussion before the revision flight on any of the subjects to be covered before first solo.

Throughout circuit revision, formal briefings or guided discussions will be required to ensure that all environmental factors affecting taxiing and the circuit have been learned by the student before presenting the student to your supervisor for a pre-solo check flight.

Remember to check English language requirements are met well before first solo is considered.

Circuit introduction

Objectives

- To take-off and follow published procedures that conform to the aerodrome traffic circuit, avoiding conflict with other aircraft.
- To carry out an approach and landing using the most suitable runway.

Considerations

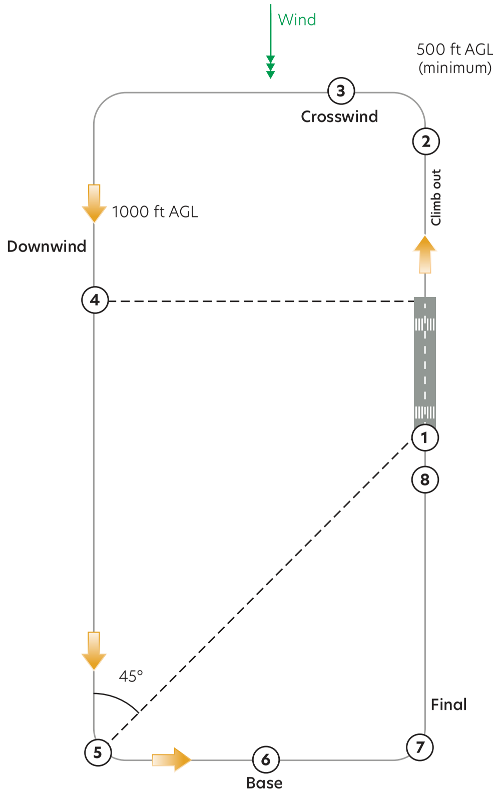
Take-off

Slipstream	Strikes tail and yaws aeroplane
Torque	Tries to rotate aeroplane and yaws aeroplane
Keeping straight	With rudder as required – look ahead
Crosswind	Tries to weathercock aeroplane, keep straight
Headwind	Reduces take-off roll – always take-off into wind
Tailwind	Increases take-off roll
Climb angle	Headwind increases climb angle
Take-off into wind	To minimise ground roll and distance to 50 feet
Power	Full power for maximum performance
Flap	Usually not used
Runway length	Calculated length required for take-off

Landing

Wind	Into wind to reduce ground roll and distance from 50 feet
Flap	↑ L and D, lower stall speed and lower nose attitude
Power	Controls RoD, more airflow over elevator and rudder
Brakes	On ground only
Runway length	Calculated length required for landing

Air exercise



① **Take-off**
- Reference point and line up checks
- Hold on brakes
- Keep straight

② **Climb out**
- Separation
- After take-off checks
- Turn at 500 feet AGL

③ **Crosswind**
- Tracking and lookout

④ **Downwind**
- Downwind radio call
- Checks
- Spacing

⑤ **Base turn**
- Lookout
- Reference point
- Carb heat HOT
- Power reduced to ______
- Turn
- Airspeed ______
- Flap – first stage

⑥ **Base leg**
- Track
- Flap – further stage(s)
- Attitude controls airspeed

⑦ **Final**
- Anticipate turn – 500 feet
- Aim point
- Attitude controls airspeed
- Power controls RoD
- Short final carb heat COLD

⑧ **Landing**
- Landing assured, close throttle
- At 50 feet nose progressively raised for roundout/flare
- Look down end of runway
- Progressively increase back pressure to control sink
- Touch down on main wheels
- Let nosewheel settle
- Keep straight
- After-landing checks – clear of runway

Airmanship

- ATC/Traffic
- Checklists
- Right of Way rules

U	Undercarriage	Down and locked
B	Brakes	Brake pressure checked, park brake off
M	Mixture	Mixture rich
F	Fuel	Fuel on fullest tank, fuel pump on, pressure checked
H	Harnesses and hatches	Seatbelt secure and doors\canopy closed

Aeroplane management

S	Suction	Suction gauge operating in the green range
A	Amps/Alternator	Alternator functioning correctly
D	DI	DI synchronised to compass and functioning correctly
I	Ice	Carb ice checked for and carb heat applied if required
E	Engine	Temperatures and pressures are in green range

Human factors

- Landing cues
- Workload/priorities

Circuit considerations

This briefing deals with those aspects of a normal circuit that were deferred during **Circuit introduction** to avoid student overload.

Objectives

To continue circuit training.

To use the touch-and-go and go-around procedures.

To use the terms and procedures employed when a deviation from the normal circuit is required.

Considerations

Touch and go

The touch and go refers to a normal landing followed by a normal take-off without stopping or braking. This procedure allows more circuits and landings to be practised, rather than stopping and taxiing back to the holding point – it's most common in a busy circuit.

This procedure is carried out only on runways of more than adequate length, assuming the aeroplane has touched down in approximately the correct place, ie, the threshold or numbers area.

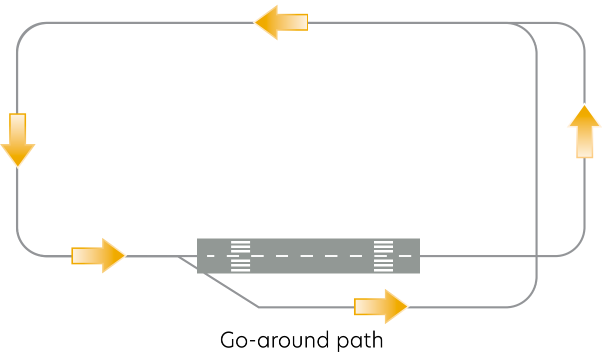
Unless in an emergency, when power must be applied first, a standard touch and go should ensure the landing phase is complete before power is increased for the 'go' phase of the exercise.

Go-around or overshoot

At any time after the approach starts the pilot may elect, or be instructed by ATC, to "go around" (see Figure 1).

Figure 1

The go-around



The instruction to go around means to discontinue the approach by applying full power (including carburettor heat OFF), climb straight ahead, retract any flap in stages, and follow the circuit pattern to position for another approach and landing.

Orbit

The orbit is a procedure used by ATC to improve separation from aircraft ahead. The use of an orbit in an unattended aerodrome circuit is **not** recommended. Extending downwind or a go-around is preferred for separation.

An orbit is most commonly carried out on the downwind leg and consists of a 360-degree medium level turn, outside the circuit pattern, which positions the aeroplane back into the downwind leg, at about the same place, approximately one minute later.

As the first half of the turn is completed, a conflict with traffic approaching head-on is a real possibility, and therefore a good lookout is essential.

An orbit on final or base (with flap extended) should be avoided. The go-around procedure is preferred because it is specifically taught before first solo, whereas low-level turns with flap extended are not.

Extend downwind

Extending downwind is another procedure used by ATC and pilots to improve separation from aircraft in the circuit ahead or joining long final. The aeroplane is flown on the reference point, parallel to the runway, for a suitable distance past the 45-degree base turn point, to achieve separation. The power setting selected at the extended base turn point will need to be higher, and a delay to both flap extension and descent may be required to regain the normal approach profile.

Repositioning

Repositioning may occur on any leg of the circuit, but it is more commonly at ATC request. This is the preferred method of repositioning where a change in wind direction makes a runway change advisable. Commonly, the aeroplane is flown to the middle of the old downwind leg and then a 180-degree turn made to position the aeroplane on the new downwind leg and the approach begun as normal. For runway direction changes that are not 180 degrees, the heading need only be adjusted to achieve a parallel track to the new runway in use.

Where cross, or multiple, runways exist follow the existing pattern to intercept the new pattern, and if that is not practical pass overhead the aerodrome to join the pattern at the beginning of the downwind leg.

Where this occurs on final, when parallel runways are in use, simply move over to intercept the final approach for the other runway.

Low-level circuit

The low-level circuit is carried out at less than 1000 feet AGL (or the promulgated circuit height), normally at 500 feet AGL, particularly in conditions of reduced cloud base. It is most commonly used by instructors, but it may be requested by the pilot or ATC. Only the briefest explanation of this term is included in this briefing for the reasons given in the notes below. How much to include should be referred to the CFI.

The low-level circuit is generally used by instructors to quickly position the aeroplane for the last part of the approach and landing so that the student can practise more landings. However, its general use is not recommended as all other legs of the circuit are either so rushed that the student has little opportunity to prepare for the landing, or are flown by you, providing the student with little opportunity to practise the other flight phases.

The low-level circuit does not provide an automatic right of way.

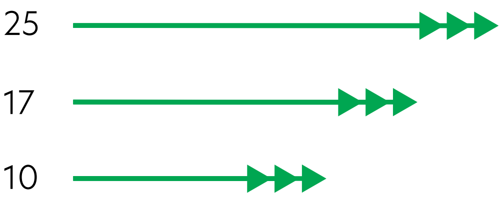
The practical application of the low-level circuit will be discussed and practised in precautionary landings. The need to teach low-level circuits before first solo should not arise (refer CFI).

Wind gradient

Wind gradient is the gradual decrease of the wind speed near the ground, due to surface friction and the air's viscosity. Discuss the affect it can have on the flare, in particular the inability to touch down at the planned point (see Figure 2).

Figure 2

Wind gradient



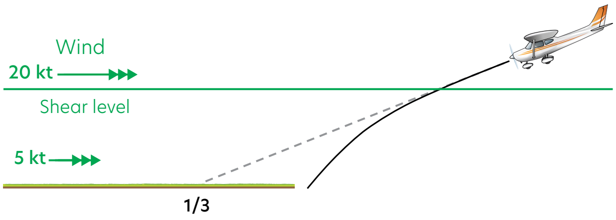
Windshear

Windshear is a sudden change in wind speed or direction, most common in winds above 10 knots, and it is a hazard at low altitude. Discuss the Terminal Area Forecast (TAF) and ATIS contents, especially the relationship between the 2000 foot wind and the surface wind.

A sudden change in wind speed or direction can result in a sudden loss of airspeed and, due to aeroplane inertia, rapid loss of altitude (see Figure 3).

Figure 3

Windshear



The correct response is to apply power to arrest the sink and adjust the attitude to maintain the airspeed.

Where windshear is encountered unexpectedly a go-around will probably be appropriate.

Where conditions of possible windshear (or gusts) are reported or suspected, it is recommended that the approach and threshold speeds are increased. For example, if the approach speed is increased by 5 knots and a sudden change of wind strength results in a decrease of 5 knots in indicated airspeed, the actual approach speed would still be correct.

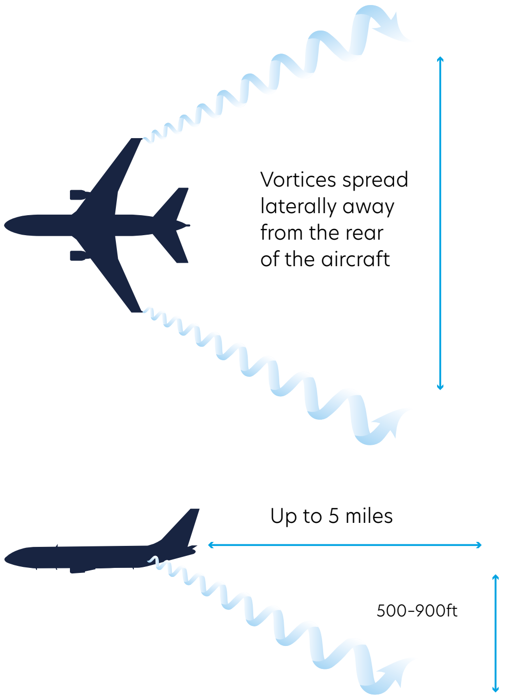
The decision to continue the approach at an increased approach and threshold speed must take into account available runway length.

Wake turbulence

Wake turbulence is a reasonably complex subject and can be dealt with only superficially in this briefing. You may prefer to make this the subject of a separate preflight briefing before the next circuit revision (refer CFI and the *Wake turbulence* GAP booklet).

Figure 4

Wake turbulence



Wake turbulence is the disturbed air left behind an aeroplane when its wing is producing lift, and includes propeller slipstream and jet blast (see Figure 4). It's encountered when following too closely behind another aircraft, especially a heavier one, and is worst when that aircraft is at high angles of attack and flying slowly – during take-off or landing.

During the production of lift, air spirals off the wingtips (or blade tips of helicopters) in vortices that increase in size behind the wing, sink, drift downwind, and gradually dissipate. Note that helicopter wake can extend above the approach path.

This turbulence can induce a roll in the following aircraft that control forces cannot counter, and therefore it is extremely dangerous.

Wake turbulence is avoided while taxiing by allowing adequate separation for propeller or jet blast – jet aircraft always have their rotating beacon on when an engine is running.

Before take-off, allow adequate separation between yourself and heavier aeroplanes ahead (up to 3 minutes in nil wind).

During the approach, avoid getting close behind, downwind or below heavier aeroplanes. For example, if there is a crosswind, fly the final approach slightly upwind of the previous aeroplane or preferably fly above its approach path and descend more steeply.

Land past the point of touchdown of the preceding heavier aeroplane – as its nosewheel touches down there is no more lift being produced.

Consider runway length available – an early go-around may be more appropriate.

Dumb-bell turn

Fortunately, the dumb-bell turn is a fairly rare occurrence. It is used when a change in wind direction makes it advisable to change the landing direction by 180 degrees. On completion of the turn, the aeroplane is repositioned onto final for landing. If a dumb-bell turn is required, the take-off is continued to a safe height (500 feet AGL minimum) and a level turn is started in the opposite direction to the original circuit direction. Then the turn is reversed until an intercept on the final approach path can be made. Clearly, the amount of time available to prepare for the landing will depend on what height and how far out the initial climb is continued to.

No professional instructor would authorise early solo circuit practise when there is any likelihood of these conditions occurring. Likewise, no professional air traffic controller would request a student on first solo to carry out this procedure.

Glide approach

Refer to the separate **Glide approach** lesson.

Airmanship

Throughout circuit training you should continue to place more and more emphasis on the student's command decision making. The pilot's priority sequence for enhancing decision making whenever a deviation from the expected occurs should be assertively stated.

Aviate — Navigate — Communicate

The responsibilities of the pilot-in-command should be discussed with reference to ATC clearances or requests. Every clearance or instruction issued by ATC must be accepted by the pilot-in-command before it is acted on. The student should be encouraged to consider the probable outcome of complying with each clearance or instruction, giving due regard to their own capabilities and that of the aeroplane, before accepting the clearance or instruction.

Where the student considers the clearance or instruction to be unacceptable, the student must be encouraged to assert their pilot-in-command responsibility.

As in all other aspects of aviation, good aviation practice or common sense is a major factor in the acceptance or rejection of ATC clearances or requests. The pilot-in-command has responsibility for the safety of the aeroplane, passengers and crew – but not a right to be obstructive. The clearance, instruction or request should be complied with if, after due consideration, no adverse outcome as a result of complying with the clearance, instruction or request can be foreseen. If the pilot-in-command believes that the safety of the aeroplane may be compromised, then clarification of the clearance, instruction or request should be sought from ATC, an alternative suggested by the pilot-in-command, or the clearance, instruction or request refused.

The student should be fully aware that once a clearance has been accepted, it must be complied with (unless a change to the clearance is negotiated, or the pilot-in-command is reacting to an emergency) and that no matter what the clearance, instruction or request and who issued it, the pilot-in-command is solely responsible for the safety of the aeroplane, passengers and crew.

This may be a good time to remind the student that although you encourage them to make as many command decisions as possible, you are the pilot-in-command. One of the measurements of readiness for solo flight is the student demonstrating pilot-in-command actions.

The requirements for VFR inside a control zone should be revised, and the conditions that require a Special VFR (SVFR) clearance introduced.

It is the responsibility of the pilot-in-command to request a SVFR clearance before any of the parameters for maintaining VFR in controlled airspace cannot be complied with. Although it is not anticipated the student would operate in SVFR conditions, some exposure during dual training may provide a controlled experience.

Aeroplane management

There are no new aeroplane management considerations for this briefing so revise the **SADIE** checks.

Human factors

Improve the student's situational awareness by encouraging them to orient themselves well, telling you which cues they are using for this will help you check that they are using as many as possible.

Air exercise

The air exercise discusses the procedures to be used for a touch and go (if applicable) and a go-around.

Touch and go

The touch and go should be a simple and logical extension of the landing roll.

Once the nosewheel has been lowered to the runway and the aeroplane remains under control, flap is raised to the normal take-off position and full power applied for another take-off. The weight is taken off the nosewheel with elevator, and the aeroplane is allowed to fly off. Keep the aeroplane straight on the centreline at all times. Don't look down into the cockpit.

Reassure the student that you will raise the flap for the student while on the runway – all they need to do is keep straight – and that once the flap is set for take-off you will say "flap up" and they are then free to apply full power and take-off. They must not apply power until you have advised them the flap is up.

Go-around

The go-around is initially started at a safe height once established on final. Ideally, subsequent practice reduces the height at which the go-around starts. Circumstances may not permit this gradual introduction to the go-around.

Throughout the procedure you should emphasise the correct priority for dealing with the unexpected.

Aviate – Navigate – Communicate

The student should be made aware that this is a normal procedure, not an emergency. The student should be encouraged to carry out a go-around (and be praised for doing so) at any time throughout the approach to touchdown, if they are not confident about any aspect or parameter of the approach or landing.

Carburettor heat is selected COLD and full power applied. Raise the nose to the level attitude, or slightly above, and reduce the flap setting in stages (as appropriate to the aeroplane type) immediately.

If flap has been extended and the aeroplane trimmed for the descent attitude, there may be a very strong pitch up when power is applied. The student must be made aware of this and be prepared to prevent the nose pitching above the level attitude.

Don't hesitate to raise flap as soon as full power has been applied, control is assured, and the attitude adjusted. It's much better to accelerate over the runway rather than among obstacles in the climb-out area.

As the aeroplane accelerates, the attitude is adjusted so that the nose is on the horizon. At a safe height (refer CFI), and safe airspeed (through ____ knots), with a positive rate of climb, the remaining flap is raised gradually and the aeroplane allowed to accelerate to the climb speed. Climb to circuit altitude.

Regardless of when circuit altitude is reached, the aeroplane should be flown upwind along the climb-out path to the normal crosswind turn point. Turning crosswind early will shorten the downwind leg and may rush the student's preparation for the approach. Any decision to turn early must consider other traffic in the circuit and must have ATC approval (if in controlled airspace).

During the go-around, flying over the runway would mean flying over any aircraft taking off. The normal procedure, therefore, is to fly just to the right of the runway, so that the pilot has the runway on the left and can observe traffic on the runway or climbing out. This procedure, as with many other general rules in aviation, needs to be tempered with good aviation practice. Where parallel runways are in use, flying to the side of the runway may conflict with traffic landing or taking off on the parallel runway (refer CFI). In this case, it may be better to fly along the opposite side, or if it is known that no aircraft are taking off on the runway ahead, to maintain runway heading. If the go-around is begun on short final or later, the aeroplane is not flown to one side of the runway during the climb out because it is known there is no traffic ahead or below that might conflict.

With the aeroplane established in the normal climb and trimmed, it may be necessary to advise ATC that you are "going around."

The other procedures described under considerations (other than low level, which is discussed in the **Precautionary landing** lesson) are demonstrated and pattered when they occur.

Airborne sequence

On the ground

The student should be familiar with the checks. They should also be doing most of the radio work on the ground by now.

The exercise

Provided the student is fully competent in normal take-offs, this exercise is a repeat of the circuit introduction, except that you will be carrying out touch-and-go landings. You will need to raise the flap on the runway for the student, until they can manage to coordinate everything themselves.

At an appropriate time, and probably not the first approach and landing, you will introduce the go-around, from a sensible height. As the student becomes more practised at the go-around, you can gradually lower the altitude at which you give the command.

After flight

Keep the student working on their checks. Inform them that you will be expecting them to be doing most of the radio work in the next lesson.

Circuit considerations

Objectives

- To continue circuit training.
- To use the touch and go, and go around procedures.
- To use the terms and procedures employed when a deviation from the normal circuit is required.

Considerations

Touch and go

- On runways with enough length can land, retract flap and take-off without stopping
- Saves time, can do more circuits

Go around / overshoot

- If for any reason the landing needs to be abandoned
- Full power, raise flap, climb ahead

Orbit

- 360° medium level turn
- Used to adjust spacing or to hold
- Commonly done downwind
- Not recommended at uncontrolled aerodromes

Extend downwind

- For separation
- Extend the downwind leg, and turn base when instructed (ATC)

Repositioning

- Usually done downwind, but can be done on any leg
- Change of direction used when there is a change of runway

Low level circuit

- Should only be done with instructor on board
- Does not give you automatic right-of-way

Wind gradient

- Wind strength decreases closer to the ground because of friction
- Affects flare – possible floating

Windshear

- Sudden change in wind speed and/or direction
- Wind needs to be 10 kts or more
- If encounter sudden drop in airspeed and/or altitude – go around

Wake turbulence

- Disturbed air caused by wing producing lift
- Aircraft produces spirals from wingtips
- Avoid by keeping safe distance from aircraft ahead, especially those bigger
- If encounter – go around

Dumb-bell turn

- Change circuit direction change by 180° turn on climb out

Glide approach

- See separate briefing

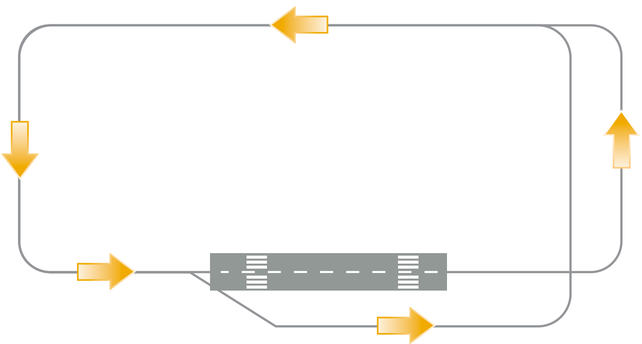
Air exercise

Touch and go

- Once nosewheel on runway, raise flap and apply full power
- Keep straight
- Take-off

Go around

- Carry out any time a safe landing cannot be made
- **Aviate – Navigate – Communicate**
- Normal procedure, not emergency
- Carb heat COLD
- Full power – beware of pitch change
- Nose to level attitude
- Reduce from full flap
- As speed increases nose on the horizon
- Safe height, safe airspeed, +ve RoC – raise flap
- Track to the right of the runway
- Continue climb out to normal crosswind turning point
- Advise ATC "going around"



Go-around path

Airmanship

- Aviate – Navigate – Communicate
- ATC clearances
- VFR minima in CTR

Aeroplane management

- SADIE checks

S	Suction
A	Amps/Alternator
D	DI
I	Ice
E	Engine

Human factors

- Orientation cues

Engine failure after take-off

Although engine failure in modern aeroplanes is quite rare, the take-off phase incorporates all the worst aspects of this type of emergency.

The aeroplane is usually heavy, slow, low and in a nose-high attitude. These factors combine to provide the least amount of height – and therefore time – available to respond to the emergency. Successfully managing an engine failure after take-off (EFATO) is dependent entirely on efficient use of the time available.

The procedure taught in this lesson has been shown to give the best chance of survival in the case of an engine failure after take-off. Where possible and appropriate during later lessons, the student should complete the manoeuvre to the ground, for example, where there is enough runway ahead to land on. Before doing this, however, consideration must be given to the human factors discussed in this briefing and the limited time available for appropriate actions, while all the time remaining in control of the aeroplane.

As with all emergency procedure training, the emergency is simulated in such a way as to ensure there is no danger to the aeroplane or crew.

Considerable time is spent on overlearning a procedure to adopt in case it does happen. The purpose of overlearning is to produce an automatic response that best uses the time available by overcoming the initial surprise or shock (startle effect) and enhancing the decision-making process.

This briefing discusses engine failure both during and after take-off.

Objective

To adopt the recommended procedure in the event of an engine failure at low level (below 1000 feet AGL).

Considerations

Common causes and their prevention

The modern aeroplane engine is a fairly simple, slow revving (2500 RPM versus the average car at 4500 RPM) four-stroke engine, and therefore it is very reliable. Its operation requires the mixing of air and fuel and the introduction of a spark. The result is quite predictable. Generally, the reasons aeroplane engines stop can be traced to the lack of one of the following components.

Carburettor ice

In conditions of high humidity, carburettor ice can form during taxiing and may be hard to detect at low power settings. Being aware of the temperature and moisture content of the air will alert you to the possibility of ice forming. There may be clues in the way the engine is running on the ground.

Selecting carburettor heat HOT is the first action, other than flying the aeroplane, to be taken in the event of any engine failure, and if carburettor icing is the cause of an engine failure it should re-establish smooth engine running. Selecting carburettor heat to HOT also provides an immediate alternate source of air to the carburettor, should the air filter have become blocked during take-off.

The risk of carburettor ice causing an engine failure is minimised by carrying out the preflight engine run-up. In conditions of suspected carburettor icing, after prolonged idling, it is advisable to cycle the carburettor heat just before take-off. Be aware of the ground surface when applying carburettor heat. Bypassing the filter can introduce dust and grass seeds into the carburettor, another possible cause of engine failure.

Always ensure that carburettor heat is selected to COLD before opening the throttle for take-off.

Air blockage

Another possible cause of the air supply being obstructed is a blockage in the carburettor air filter. In this situation, the carburettor heat, which bypasses the air filter, will provide an alternate source of air to the carburettor. The risk of filter blockage is minimised by carefully examining the air intake during the preflight inspection.

Fuel contamination

The most probable cause of engine failure is fuel contamination, ie, something in the fuel – most commonly water.

Most students are surprised to learn that mechanical failure is not the most common cause.

The risk of fuel contamination is minimised by inspecting a fuel sample during the preflight and after-refuelling checks – looking for foreign objects, colour and smell, as well as carrying out the pre-take-off engine run-up. Be aware that immediately after refuelling some water, if present, will still be in suspension, and a fuel check done too soon after refuelling may not discover this.

Be aware that if the aeroplane is not on level ground, a fuel sample check may not be capturing any water or contamination present.

Fuel starvation

Fuel starvation occurs when there is fuel on board but it's not getting to the engine.

The most common cause of fuel starvation is the pilot selecting the wrong fuel tank or placing the fuel selector in the OFF position by mistake. Other less common but possible causes are either engine-driven fuel pump failure or blocked fuel lines, injectors or fuel vents.

To help avoid fuel starvation, the student must be familiar with the aeroplane's systems, carry out the engine run-up before take-off, and apply sound fuel planning and management procedures.

Fuel exhaustion

Fuel exhaustion occurs when there is no useable fuel on board, and is less likely to be a factor of EFATO than fuel starvation.

The most common cause of fuel exhaustion is poor in-flight decision making – simply running out of fuel. Another cause is leaving the fuel caps off, this allows fuel to be sucked out by the low-pressure area over the wing surface.

Fuel exhaustion is avoided by careful preflight planning, a thorough preflight inspection and being aware of how much fuel there is on board at all times. Use a fuel management procedure as outlined in the *Fuel management* GAP booklet.

Spark

During take-off the engine is working at its hardest and, although mechanical failure is still the least likely cause, the risk of mechanical failure is increased.

Statistically, the first reduction in power after take-off is the most common time for a mechanical failure to occur. Therefore, if a reduced power setting is to be used for the climb, full power should be maintained to a safe height, and the aeroplane cleaned up and established in the climb before power is reduced.

A thorough preflight inspection and engine run-up should be completed to check for any signs of impending mechanical failure.

The aborted take-off

Early in the take-off roll, temperatures, pressures, RPM and airspeed are quickly scanned for normal readings. If anything about the take-off roll appears abnormal – including the sound – something blocks the runway, or at ATC request, the take-off should be abandoned, also called 'aborted', by closing the throttle, braking as required, and keeping the aeroplane straight.

Engine failure after take-off

Remind the student of the concept of Aviate – Navigate – Communicate.

In any emergency situation the first and overriding priority of the pilot is to **fly the aeroplane**. Then if time permits the next two priorities can be attended to, navigate and communicate – in that order. Do not allow your students to feel that the first priority is to communicate, especially if they are trying to respond to requests from air traffic control.

Aviate

Because the aeroplane is slow, low and in a nose-high attitude, an engine failure at low altitude provides little time for decision making. Therefore, the first response must be a positive and automatic movement to lower the nose to maintain best available flying speed and to close the throttle to stop any engine surges affecting the glide. The student must accept that if the engine fails at low level they are committed to a landing.

A pre-take-off safety brief will help avoid any mindset and improve decision making in the event of an emergency.

Navigate

The second response turning into wind (if applicable or necessary) and choosing a suitable landing site within gliding distance. Without compromising the safe outcome of a simulation, demonstrate good decision-making by talking the student through your decision-making process. This is particularly important when deciding to select flap.

Landing site considerations

For a familiar runway, anticipated options should already be available, subject to wind, airspeed, load, and height considerations. The choice of landing sites will be limited by the height and therefore time available, but there is one sure way to improve your options – always use full runway length. Runway behind you is useless. From full length an engine failure at low altitude may present you with the perfect forced landing area – the runway ahead.

The most important consideration when selecting a suitable landing site is to avoid major obstacles – to keep the cabin intact.

Common practice is to limit the choice of landing site to no more than 45 degrees either side of the nose; a simpler and more realistic choice may be to choose anything in the windscreen.

Do not turn back to the runway. A successful turn back to the runway is beyond the capabilities of most pilots.

Communicate

This is always last on your list. If time, make a MAYDAY call to alert others of your situation.

The go-around or overshoot

Once the student has completed the EFATO procedure, you'll be asking them to carry out a go-around.

In this instance, the instruction to go-around means to discontinue the glide by applying full power while keeping straight with rudder, raising the nose attitude to the horizon, climbing straight ahead, retracting any flap, and continuing the climb out.

The early go-arounds should be initiated as soon as the student has carried out the immediate actions of lowering the nose and deciding where they will land. Once the student's experience increases they can be initiated at lower levels when flap decisions are committed to.

Take-off safety brief

Because the time available for decision making is short, the anticipated response to an engine failure is briefed before line up.

This type of pre-take-off preparation is common in multi-engine aeroplanes and, although the choices in a single-engine aeroplane are limited, it is highly recommended. Verbally or mentally preparing a response, through visualisation before an unexpected emergency, has been shown to greatly increase the chances of success.

The take-off safety brief should include the intentions of the pilot-in-command in the event of an engine failure during the take-off roll and after take-off.

The briefing needs to consider the conditions on the day, particularly the direction of the wind in relation to the runway in use. If the wind is not directly down the runway but slightly across, then if an engine failure occurs after take-off, a gentle turn into wind would result in increased headwind and a shorter landing roll.

The type of terrain off the end of the runway should be visualised and suitable landing areas recalled from memory of earlier flights off this runway.

An example:

"Engine failure or aborted take-off before one third of the way along the runway – I will lower the nose, close the throttle and land on the remaining runway. Engine failure after one third of the way along the runway – I will lower the nose, close the throttle, select the best option and execute trouble checks and MAYDAY call if time permits."

Airmanship

So that there is no confusion between the simulated engine failure and an actual occurrence, advise the student that you will close the throttle and use the word "simulating". Any partial power reduction by you during the take-off is to be considered by the student as a total failure. You could use the following phrases.

"I will simulate the engine failure after take-off by closing the throttle. You are to assume that any power reduction (partial or otherwise) by me during the climb out is a total power failure simulation. During the simulations power will always be available should we need it."

Any checks that would be carried out in the event of an actual engine failure, which are not actually carried out during the simulated exercise, are known as 'touch checks'. These will be clearly identified in the briefing, and a chance available for the student to familiarise themselves before the flight. A touch check requires the student to state the check verbally and touch the appropriate control, preferably with only one finger, but not perform the required action.

At controlled aerodromes, ATC must be advised of the intention to carry out a simulated engine failure after take-off, and advised when the simulation is complete. Advise the student that you will make these calls.

At uncontrolled aerodromes, a traffic call is made to keep other traffic informed of your movements.

By varying the height at which the simulated engine failure occurs, you are increasing and decreasing the available options for the landing site and the amount of checklist items the student can complete. The student will be making decisions based on the time they have available, developing their aeronautical decision making skills (ADM).

The student should be advised that this exercise is never to be practised solo.

EFATO simulations are not to be carried out with passengers on board, nor when following traffic may conflict.

Trouble checks

Trouble checks are a way to diagnose (or troubleshoot) the causes of an engine failure and hopefully reinstate engine operation. They cover the most common causes, and give you an increased chance of getting the engine running again.

Critically though, trouble checks are only completed when there is enough time. If there is not enough time - concentrate on flying the aeroplane, ie, first lower the nose. It's vital that the aeroplane is consciously flown at all times, and that the pilot is not distracted by carrying out the checks, failing to fly the aeroplane.

Whenever power is reduced, the immediate action is to aviate as above, then if time permits select carburettor heat HOT, close the throttle, and carry out the trouble checks. Make sure the student gets into this habit quickly, and it becomes automatic.

F Fuel

Fuel selector ON, fuel pump ON (if applicable), change tanks (touch).

Fuel pressure and the contents gauges are checked and compared with the fuel tank selected.

M Mixture

Mixture RICH, carb heat HOT, primer LOCKED.

These are rechecked and the mixture, in the case of partial power, altered (touch) to see if there is any improvement in power or smoothness.

I Ignition

Ignition LEFT, RIGHT or BOTH (touch), check temperatures and pressures.

Trying LEFT (touch) and RIGHT (touch) magneto positions for smoother running may keep the engine running. Try to restart the engine with the ignition key (touch) if the propeller is not windmilling.

Check the temperatures and pressures for any reading outside the green range.

Further elements of the trouble checks will be introduced in following lessons.

Shutdown checks

These are completed if the aeroplane will be landing in order to minimise the risk of fire, but only if there is time available to do them.

F Fuel

Fuel OFF

Pump OFF and tank selector to OFF.

M Mixture

Mixture IDLE CUT-OFF

To stop all fuel from flowing to the engine.

I Ignition

Ignition OFF

To ensure there is no spark available to ignite any fuel.

M Master switch

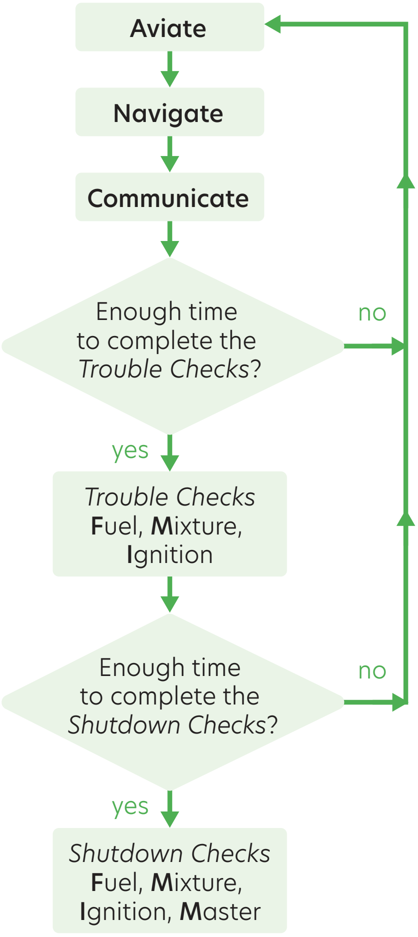
Master switch OFF

After you have made the MAYDAY call and the final flap selection is made, the master switch is turned off to remove power from the aeroplane.

This sequence may be presented in the form of a flow chart (see Figure 1).

Figure 1

Shutdown checks



Aeroplane management

Since aeroplane systems management errors are often the root cause of in-flight emergencies, consideration must be given to systems management, regardless of how simple those systems appear. You may like to use a schematic or model to describe the fuel system, as well as providing a handout. The student should operate the fuel cocks, actually turning the fuel off and on, during the preflight inspection.

During the preflight inspection make sure loose articles are secured or removed, there is little point in making the perfect forced landing only to be hit in the head by a heavy article.

As large throttle movements will be made while operating close to the ground, those movements need to be smooth.

Encourage the student to listen to the normal sounds of the aeroplane so that they can be aware of abnormal sounds.

Avoid 'ramming' the throttle to the maximum stops when carrying out a go-around.

Human factors

Checklists, mnemonics and careful preflight planning allow the student to improve their information processing capabilities.

An engine failure close to the ground can be a stressful experience for the student – even if it is simulated. For the first few engine failures give the student plenty of notice, and as their experience and competence increases, slowly remove the advanced notice.

Continued practice and overlearning the procedure will reduce their stress levels, and their responses will become automatic.

Air exercise

Talk through the elements of an appropriate take-off safety brief. Give the student a written version of your brief.

Aborted take-off

Aviate	Close the throttle
Navigate	Keep straight and use brakes as required – backpressure is used as required to keep the aeroplane weight off the nosewheel
Communicate	Advise ATC (if applicable)

Keep the cabin intact. Don't run the aeroplane nose into fence posts, steer between them.

The reason for abandoning the take-off is simulated by you and the student is talked through the actions. This may be simulated soon after full power is achieved, by advising the student, for example, that oil pressure is (simulated) zero.

Engine failure during take-off (early in the take-off roll) is simulated by partially closing the throttle.

Engine failure after take-off

Engine failure after take-off is simulated by closing the throttle.

Aviate	Fly the aeroplane. **Lower the nose** – close the throttle and achieve best available glide speed. Any nose-low attitude will avoid the stall. Select carburettor heat HOT (as this is a likely cause of rough running) and close the throttle, because a temporary surge in power may divert the student and cause indecision.
Navigate	Follow the take-off safety brief and choose a landing site from anything in the windscreen, within easy reach and clear of major obstacles to keep the cabin intact. Use flap as required to reach the landing site.
Communicate	Transmit MAYDAY (touch) if time permits and when full flap has been selected, master OFF (touch). The MAYDAY transmission from low level may have limited value at an uncontrolled aerodrome, as would the selection of 7700 on the transponder. At a controlled aerodrome, the take-off is usually monitored by ATC and only an abbreviated call should be required, for example, "MAYDAY – aeroplane registration – engine failure".

The priorities of the pilot-in-command should focus on landing into wind and keeping the cabin intact. However, if time permits the attitude can be adjusted for best glide, carburettor heat applied, and the trouble checks (FMI) carried out.

F Fuel

Fuel pump ON, pressure checked, change tanks (touch), contents checked.

M Mixture

Mixture RICH, primer LOCKED.

I Ignition

Ignition on LEFT or RIGHT or BOTH (touch).

If time permits, the shutdown checks can be completed to minimise fire risk.

F Fuel

Fuel OFF (touch)

M Mixture

Mixture IDLE CUT-OFF (touch)

I Ignition

Ignition OFF (touch)

M Master

Master switch OFF (touch)

Some things are beyond our control, but by paying proper attention to all preflight preparations, we can help to avoid an EFATO. Sticking to the priorities of Aviate – Navigate – Communicate greatly increases the chances of survival.

Airborne sequence

On the ground

Sitting in the aeroplane, before start up, demonstrate the touch checks, and have the student complete them for themselves. They should also move the fuel selector, if they haven't had a chance to already.

At the holding point, run through your take-off safety brief, and ask them to do one next time.

The exercise

Even though this briefing has concentrated on the EFATO and aborted take-off, the student is still working on the circuit and landing. Not every take-off or landing will be an opportunity to practise these actions. Pick appropriate times to carry out these exercises, taking into account student workload and traffic.

Generally you will not carry out a simulated engine failure on take-off from a touch and go, unless there is sufficient runway available, so ensure you plan when to cover each exercise carefully.

When traffic permits, start with a simulated aborted take-off. As discussed in the briefing, you will close the throttle and talk the student through the actions you want them to carry out. You may want to use a vector that is not in current use.

At the next good opportunity (having let them carry out at least one normal circuit and landing), simulate the engine failure during take-off. Early in the take-off roll, from a full length take-off, partially close the throttle and talk them though the actions you want them to carry out.

At a suitable time, when traffic permits, simulate the engine failure after take-off, don't forget to say "simulating." The first simulation should be carried out from a generous height so the student has time to take the actions required.

It cannot be stressed enough that you must keep in mind the objective and the safety of the aeroplane while providing the student with the opportunity to practise command decision making. Once the aeroplane nose has been lowered; a decision made as to the landing site; an attempt made to position for a landing; and flap selected or considered; the objective has been achieved, and the instruction to "go around" should be given. Only after these basic actions have become automatic, and where height and time permits, should any attempt to complete checks be encouraged.

As competence is achieved and circumstances permit, EFATO to a landing provides the complete experience and gives the student a true appreciation of the limited time available and the need to prioritise the actions.

After flight

Carry out the debrief.

Ask the student to learn their trouble checks and shutdown checks, and to have thought about a take-off safety briefing before the next lesson.

Engine failure after take-off

Objective

To adopt the recommended procedure in the event of an engine failure at low level (below 1000 ft AGL).

Considerations

Cause	Prevention
Carb ice	• Be aware of temp and humidity • Carb heat HOT • Preflight run-up
Air blockage	• Carb heat HOT – alternate air • Preflight inspection
Fuel contamination	• Water or solid particles in the fuel • Preflight fuel check and sample
Fuel starvation	• Wrong tank selection (or OFF) or fuel pump problems • Preflight run-up
Fuel exhaustion	• Run out of fuel • Preflight planning and inspection
Spark	• Preflight inspection and run-up

Aborted take-off

- Early in the take-off roll, with runway available, close throttle, braking as required, keep straight

Engine failure after take-off

Aviate
- Lower nose, close throttle

Navigate
- Choose landing site, flap decisions

Communicate
- Tell ATC and traffic

Go-around

- Full power, keep straight with rudder, raise the nose attitude to the horizon, climb straight ahead, retracting any flap, continuing climb out

Take-off safety brief

- Intentions in the event of an EFATO

Air exercise

Aborted take-off

Aviate
- Close throttle

Navigate
- Keep straight, brake as required

Communicate
- Tell ATC and traffic

Engine failure after take-off

Aviate
- Fly the aeroplane – lower nose, close throttle
- Carb heat HOT

Navigate
- Choose landing site from anything in the windscreen. Do not turn back.
- Flap as required to make it

Communicate
- MAYDAY
- Land into wind and keep cabin intact

Trouble checks

F	Fuel Selector ON, fuel pump ON, change tanks (touch)
M	Mixture RICH, carb heat HOT, primer LOCKED
I	Ignition BOTH

Shutdown checks

F	Fuel OFF
M	Mixture OFF
I	Ignition OFF
M	Master OFF

Airmanship

- Pre-take-off safety brief
- Aviate – Navigate – Communicate
- "Simulating"
- Touch checks
- Advise ATC and traffic
- Trouble checks
- Shutdown checks

Aeroplane management

- Systems management
- Loose objects in cabin
- Smooth throttle movements
- Listen for 'normal' sounds

Human factors

- Learn checklists and use mnemonics
- Plenty of practice available
- Avoid mindsets – practise, currency and pre-planning

Flapless landings

This briefing and exercise is practised before first solo (refer CFI) to prepare the student for the unlikely event of flap failure during early solo circuit consolidation. It must be assumed that flap failure will not have been detected before starting the base turn, where flap is first selected.

Objective

To carry out a flapless approach and landing.

Principles of flight and considerations

In all cases where a systems failure or unexpected deviation in procedures occurs – **Aviate – Navigate – Communicate**.

Aeroplane system

Although the possibility of failure is rare, the student needs to know how the aeroplane's flap system works and what can be done, not only to deal with any problems arising from its operation, but also how to prevent problems occurring.

Describe the aeroplane's flap and electrical systems (even if the aeroplane has manual flap operation) with emphasis on their inter-relationships. Use schematics, actual components, models and handouts (refer Flight Manual).

Detection

The risk of this failure going undetected can be minimised by a thorough preflight inspection, mitigated by sound aeroplane systems knowledge, and possibly highlighted before flap selection by carrying out the SADIE checks (A = Amps or Alternator for electrically actuated flaps).

It is probable though that a flap failure will not be detected until flap is selected, usually in the base turn. This is no place to deal with a systems failure, so a go-around is carried out. The climb to circuit altitude uses the full length of the climbout leg, giving a long downwind leg to consider options and plan for a flapless approach.

Causes

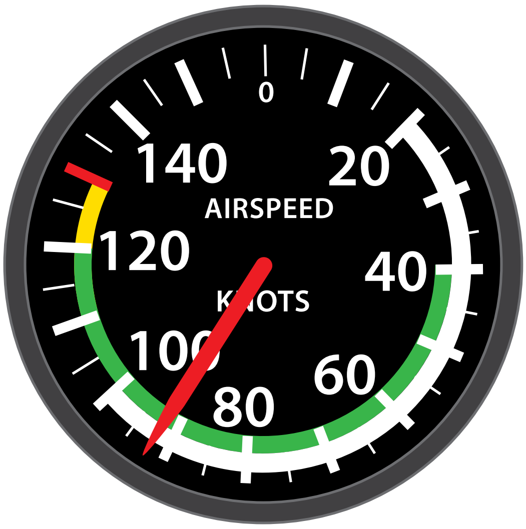
The most probable causes of flap failure are mechanical linkage failure (manual or electric flap), electric flap motor failure, or electrical current failure.

Another possible cause, that should never occur, is flap overspeed. If the flap has been extended or left extended at speeds in excess of the manufacturer's recommendation, the flap or linkages may be damaged. If this occurs, flap retraction may not be possible, with a consequent degradation in flight performance. Worse than this, is the possibility that the flap will retract unevenly, causing uncontrollable roll. A third possibility is that loads on the electric flap motor will cause it to burn out with the consequent risk of fire. This damage can go undetected, and may not result in an immediate flap failure, but may occur on later flights.

This malfunction is avoided by never exceeding the V_{FE} speed (Velocity for flap extension – white arc) with flap extended (see Figure 1).

Figure 1

Airspeed indicator



Diagnosis

Once the aeroplane is established in level flight at a safe altitude, the possible causes of the systems failure can be considered.

If electrically operated flaps fail, check the master switch is ON, the flap circuit breaker is set (or if popped reset only once), and the alternator or generator output and battery state tested (if applicable). In addition, a visual check of flap position is made to ensure that it is not the flap position indicator that has failed. The visual check should also look for any asymmetric condition.

Procedure

With flap up, the stalling speed is greater than with flap extended. To retain the same margin of airspeed over the stall speed, the approach and threshold speeds are increased by about the difference in the aeroplane's stall speed clean, and the stall speed with full flap – commonly 5 knots for light aeroplanes.

This increase in threshold speed will result in a longer landing distance, and therefore the suitability of the runway should be considered. Neither the group rating system, nor the P-Charts, allow for a flapless landing.

Without the increased drag provided by flap, the power setting required to control the descent will be lower, the descent angle will be shallower, and forward visibility will be poorer.

Airmanship

Situational awareness is improved through systems knowledge and routine systems checks.

Revise the SADIE checks, as introduced in the **Circuit introduction** lesson.

The higher approach speed can affect your judgment of the spacing between you and the aircraft in front.

Aeroplane management

As a result of the decreased drag, only small power changes will be required to alter the rate of descent.

Human factors

There is a tendency to accelerate as the student unconsciously seeks the lower nose attitude they are familiar with from a normal approach and landing.

The simplicity of the manual flap extension system requires minimal systems knowledge. Electrically operated flap requires more systems knowledge and provides the student with the opportunity to practise problem solving.

Air exercise

A flap failure will be simulated at the base turn or when flap is first selected, and a go-around carried out for the first occurrence.

For further simulated flapless landings, the student should assume that the failure is identified downwind, and there is no need to complete the go-around.

Downwind

The systems checks are carried out (if applicable) as well as the normal radio call and downwind prelanding checks.

The suitability of the runway in use is considered, and a decision made on the appropriate approach speed to be used.

If the runway in use is not suitable, and a diversion to another aerodrome is preferred, practice in this procedure should be given before first solo (refer CFI).

Downwind spacing is assessed, and an appropriate power setting at the base turn point is selected. Because of the decreased drag without flap and the desirability of a powered approach, it is common practice to extend the downwind leg and set the same power setting as a normal circuit, so that some power will be used throughout the approach.

An alternative method to stretching the circuit out, is to extend downwind only slightly and initially use a much lower power setting. As the aeroplane sinks onto the correct glide slope or approach path, power is slowly increased until the desired rate of descent is achieved. The aim point should not move up or down but remain steady in the windscreen.

Base

The base turn will have a lower power and higher nose attitude. Ensure the student trims the aeroplane for the descent. Because of the aeroplane's higher momentum, the turn onto final will need to be anticipated earlier than normal.

The approach

The approach is flown as normal with the attitude selected to maintain the higher approach or threshold speed and trimmed. Only small adjustments in power should be required to control the rate of descent.

The noticeable differences in this approach are:

- the higher nose attitude required to maintain the desired airspeed, which results in reduced forward visibility (runway may be largely obscured), and
- the effect of power changes on the rate of descent.

As always, if attitude or power is altered some adjustment to the other component will be required to maintain the desired performance.

Power + Attitude = Performance

Landing

Because the aeroplane is already in a higher nose attitude than normal with a lower rate of descent than normal, the round-out is less pronounced and only a slight hold-off is used. The aeroplane is then allowed to sink in a slightly nose-high attitude to prevent the nosewheel taking the landing loads. The nosewheel is then lowered and brakes applied as required, aft elevator is used to keep the weight off the nosewheel.

As the student is familiar with holding off for the normal fully flared landing, resisting an over-flaring action and allowing the aeroplane to sink onto the runway may take some practice.

As with all powered approaches, runway length available and aim point notwithstanding, it is desirable to touch down just inside the threshold. If a prolonged float is permitted to develop, a go-around may be appropriate.

Airborne sequence

Before flight

By this point the student should be able to do all of the radio work for the flight, with minimal input from you.

As discussed at the end of the last lesson the student will do their own take-off safety brief.

The exercise

Start with a normal take-off and simulate flap failure on the base turn of the first circuit, by saying “assume you now have a flap failure”.

After the simulation of flap failure, and the repositioning of the aeroplane downwind by the student, the circuit continues normally until the base turn.

Since the flapless landing will usually be a full stop, the next take-off may be a good opportunity to practise an EFATO. Be careful not to fill all of the circuit lessons with emergencies, the student still needs plenty of practice at normal landings.

After flight

Mention in your debrief any go-arounds that were carried out, and praise the student for taking the initiative – if that is what they did.

The next lesson will be crosswind circuits, so long as the conditions permit. If not, continue practicing circuits, reminding the student to expect the emergency procedures you have covered in all following lessons.

Flapless landings

Objective

To carry out a flapless approach and landing.

Considerations

- In all cases, when faced with the unexpected
- **Aviate – Navigate – Communicate**

Flap system

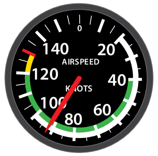
- Flap system operated by ______
- Electrical system diagrammatics
- Flap operating system diagrammatics

Detection

- To help detection of this failure before getting airborne
- Thorough preflight inspection
- Sound systems knowledge
- Regular SADIE checks
- Probably won't detect it until base leg
- Once detected – go-around

Causes

- Mechanical linkage failure (manual or electric flap)
- Electric flap motor failure
- Electrical current failure
- Overspeed – should never happen
- Always limit speed to below V_{FE} before deploying flap

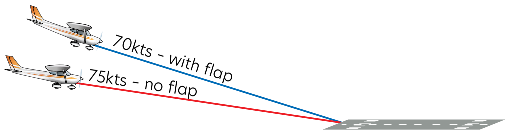


Diagnosis

- Once in level flight, can then diagnose problem
- Check electrics for indications – master ON, CB set, battery output
- Visual check for indication failure

Procedure

- Stall speed ↑ therefore approach speed higher (5 kts)
- Longer landing distance – P-charts have no detail
- Less power required
- Descent angle shallower
- Less visibility over the nose



Air exercise

- Will simulate late downwind
- Carry out a go-around and position downwind

Downwind

- Downwind checks and radio call
- Assess runway length
- Confirm appropriate approach speed
- Choose power setting for approach
- Extend downwind leg

Base

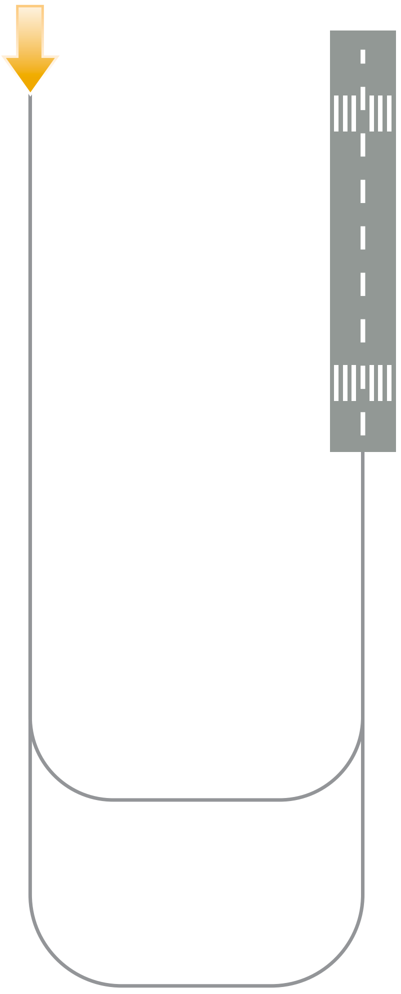
- Lower power
- Higher nose attitude
- Trim
- Anticipate turn onto final

The approach

- Attitude to maintain higher approach speed
- Small power changes to adjust RoD
- Higher nose attitude – less forward visibility
- Attitude + Power = Performance

Landing

- Less round-out
- Slight hold-off
- Do not over-flare – wait for touchdown
- Caution floating – may require go-around



Airmanship

- Good systems knowledge
- SADIE checks
- Higher approach speed

Aeroplane management

- Small power changes to adjust approach path

Human factors

- Higher nose attitude causes illusion and acceleration

Crosswind circuit

This briefing primarily deals with the differences between a normal circuit, where the wind is straight down the runway in use, or little wind exists, and a circuit where the wind is at an angle to the runway in use.

The student should already be familiar with compensating for drift on the crosswind and base legs of the circuit. However, when landing in a crosswind, the aeroplane must be aligned with the runway before touchdown. If this is not done, there is a risk of damage to the undercarriage and the aeroplane may run off the runway.

Objectives

To correctly position the aeroplane controls while taxiing.

To compensate for drift throughout the circuit.

To take off and land in crosswind conditions.

Considerations

During taxiing and throughout the take-off and landing, when the wind is at an angle to the runway, the aeroplane will have a tendency to weathercock or swing nose into wind.

Since taxiing in any wind will invariably result in some crosswind being experienced, revise the correct positioning of the aeroplane's controls during taxiing (refer to the **Taxiing** briefing).

When climbing out or approaching to land, with the wind at an angle to the runway, an allowance for drift will need to be made so that the aeroplane tracks straight over the ground along the extended centreline.

Maximum demonstrated crosswind

The maximum demonstrated crosswind component (in knots) in the Flight Manual is the figure at which factory testing has shown that directional control can still be maintained. It is affected by the size of the rudder, its distance from the C of G, and the availability of asymmetric braking. It is not a legal limitation, but a guide to what limit should be applied to crosswind landings. It is modified by several factors; for example, technique, individual currency, and competency.

State the maximum demonstrated crosswind component for this aeroplane, as well as any club or organisation limit.

Calculation of crosswind component

To calculate the crosswind component, the pilot must first know or estimate the wind velocity (W/V) – its speed and direction.

This information may be provided by METAR – routine meteorological reports, TAF – aerodrome forecasts, ATIS – the Automatic Terminal Information Service, the ATC control tower, or windsocks.

METAR and TAF winds are given in degrees **true** and must first be converted to magnetic in order to calculate the angular difference between runway heading (magnetic) and wind direction.

In some instances, the crosswind component may be stated – requiring no further calculations.

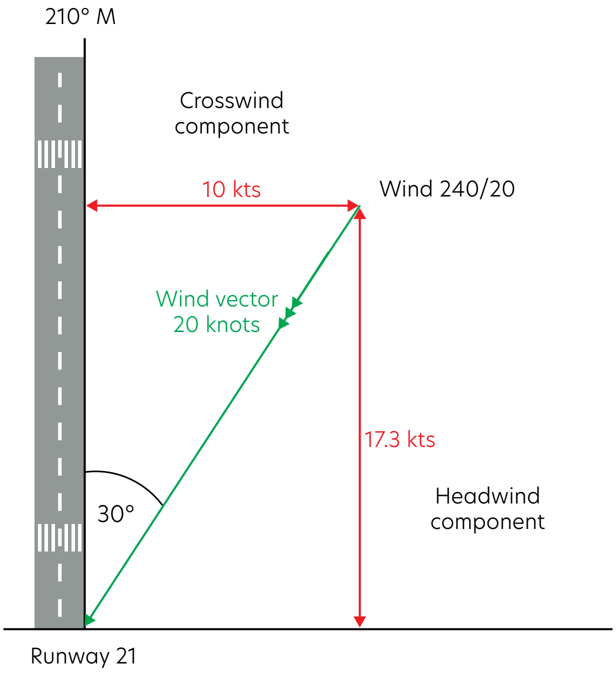
Once the angular difference between wind direction and the runway heading is known, the various methods of calculating the crosswind component can be discussed.

Vector diagram

The vector method requires pencil, paper, protractor and ruler. As an example, assume a W/V of 240 degrees magnetic at 20 knots and a runway heading of 210 degrees (RWY 21). Calculate the angular difference between the runway and the wind direction; this is the wind angle, in this case 30 degrees. Draw a vertical line to represent the runway. From near the bottom of this line, draw a line at the wind angle from the vertical, 20 units (wind speed) long. Break this vector down into its vertical and horizontal components and measure these to give headwind (17.3 knots) and crosswind (10 knots), see Figure 1.

Figure 1

Vector diagram to calculate crosswind component



Flight manual

Commonly, a vector diagram is supplied in the Flight Manual in graph form and is a more practical method of calculating crosswind.

It's a good idea to include a photocopy of this graph in the handout to this lesson and to have a large laminated version for reference during the briefing.

Navigation computer

Although the presentation is a little different, the same calculation can be made using the navigation computer.

Windsocks

Most aviation windsocks are 25-knot windsocks. This means that when the wind strength is 25 knots the windsock stands straight out. The angular difference between runway and wind direction is estimated visually and may require a mental calculation to derive the crosswind component (see Formula below).

Tower

Where ATC is provided on the aerodrome, you can request the crosswind component from the tower, but your student should be able to calculate it for themselves using one of the methods above.

Formula

The crosswind component is equal to the speed (V) of the wind multiplied by the sine of the angular difference (XWC = V × Sineθ). Therefore, in the example given above (Rwy 21 – W/V 240/20) the angular difference is 30 degrees, and the sine of 30 degrees is 0.5. This means that half the wind strength is crosswind (20 × 0.5 = 10).

To be completely accurate this method requires a calculator or memorisation of the various sines of angles between 0 and 90 degrees. However, there is a simple way to estimate it.

Imagine that the minutes on the face of your watch are equivalent to the angular difference between the runway and the wind direction. If the difference is 30 degrees, then thirty minutes is half way around your watch face; therefore the crosswind component is half the wind strength. If the angular difference is 45 degrees; then that is three-quarters of the way round your watch face and the crosswind component is three-quarters of the wind strength. If the angular difference is 60 degrees, or more, then consider the crosswind component to be the full strength of the wind (see Figure 2).

Figure 2

Using a clock face to estimate crosswind component

Further considerations

The ability to maintain directional control about the normal axis is the limiting factor for crosswind landings. Although it may be easy enough to keep the aeroplane aligned with the runway during the round-out and landing, as the airspeed decreases, rudder effectiveness will reduce and it may be difficult to prevent weathercocking. Therefore, as the crosswind component increases, the amount of flap used for the landing is normally reduced. This reduces the surface area on which the crosswind can act after landing and therefore improves directional control.

Although the landing distance may be adequate when calculated using the group rating system or P-charts, any landing with reduced flap will increase the landing roll. In addition, as with any gusty conditions, if the crosswind is not steady an increase in approach speed may be required to compensate for windshear and gusts.

Therefore, the pilot-in-command must consider the runway's overall suitability in relation to crosswind component, approach/threshold speed and available length.

Remind the student to anticipate the effect of a strong crosswind on the groundspeed, in particular on base leg.

Airmanship

Calculating the crosswind component; assessing the gustiness of the day; reviewing the aeroplane's limitations; and discussing the configuration to be used, all contribute to improving the student's situational awareness.

The aeroplane can land in crosswinds of greater than the demonstrated crosswind component provided the correct technique is used, and it is entirely necessary to do so.

Where this exercise is simulated using a non-active runway, remember aircraft taking off and landing into wind have right of way.

Aeroplane management

The controls must be positioned correctly, taking account of the wind, when taxiing, on take-off and landing.

Discuss the use of brakes as required to assist directional control.

Human factors

In accordance with aeronautical decision making (ADM) principles, the student should be asked on subsequent flights to assess other runways for landing suitability.

Air exercise

Take-off

On lining up, the high reference point used to keep straight during the climb will need to be adjusted from normal to prevent drift, and provide a straight track over the ground along the extended centreline. The ailerons are fully deflected into wind and the elevator maintained neutral or very slightly down.

During the take-off roll the amount of aileron is reduced as the increasing speed makes the ailerons more effective and some weight retained on the nosewheel to improve directional control.

At a safe flying speed the aeroplane is rotated with ailerons neutral. The aim is to lift off cleanly, preventing the aeroplane from skidding sideways across the runway. In addition, the higher rotate speed will allow the aeroplane to accelerate quickly to the nominated climb speed. Using the nominated high reference point as a guide, after liftoff a gentle balanced turn into wind is made to track along the climb-out path.

Circuit

During the climb out, ensure the wings are level and the aeroplane is in balance. Check for straight tracking and adjust the reference point as necessary to maintain the extended centreline.

On the crosswind leg, select a reference point with an allowance for drift in the normal way. A component of head or tailwind may become apparent in the distance travelled over the ground to reach circuit altitude.

The turn onto downwind should be made at the same distance out as a normal circuit. A wider downwind leg may be advisable if a particularly strong crosswind toward the runway exists, as this will decrease the time spent on the base leg. More commonly, the effects of a headwind or tailwind on the crosswind leg will require less or more anticipation of when to start the turn onto downwind. A suitable reference point is chosen, so as to track parallel to the runway. The approach is assessed and a decision made on runway suitability, approach/threshold speed and maximum flap setting to be used. The correctness of the downwind spacing is assessed and if necessary, the reference point altered to maintain a parallel track.

The turn onto base is normal and continued onto a suitable reference point with an allowance for drift.

Once established on base leg, additional flap up to the maximum to be used for the landing is normally extended.

The head or tailwind component experienced on base will affect the turn onto final and must be anticipated. The turn is continued onto a suitable reference point into wind that allows for drift, and tracks the aeroplane straight along the extended centreline.

Throughout the descent the aiming point is monitored in the normal way and the power adjusted to maintain a steady rate of descent to touchdown – power controls the rate of descent.

The recommended crosswind landing technique is a combination of the following two methods, the 'kick-straight' method and the 'wing-down' method.

The kick-straight method

The advantage of this method is that the aeroplane is flown in balance throughout the approach, round-out and hold-off. The disadvantage is that it is not easy to master.

On the approach, the aeroplane is crabbed into wind, and just before touchdown, brisk or positive rudder is used to yaw the aeroplane's nose into line with the runway. Into-wind aileron is used to keep the wings level.

Although this method sounds simple at first, it takes considerable skill in timing the application of rudder. Too early, and the aeroplane will drift downwind, touching down with sideways loads, perhaps off the runway. Too late, and the aeroplane will touch down at an angle to the runway, applying large sideways loads and the aeroplane may rapidly depart the runway.

The wing-down method

The advantage of this method is its ease of execution, but there may be limitations in the Flight Manual that affect this method.

On short final the aeroplane's nose is aligned with the runway by applying rudder and sufficient into wind aileron, to prevent drift, while controlling speed until the flare with elevator. This results in the aeroplane sideslipping into wind at a rate that negates the drift.

The round-out and hold-off are flown in this wing-down attitude and the landing made on the windward wheel first.

Although this method sounds more difficult, it is easier to execute and requires less judgement.

Many modern light aeroplanes have a restriction on sideslipping, especially with flap extended, and therefore the recommended procedure is a combination of these two methods.

The combination method

Throughout the approach, the aeroplane is crabbed into wind, in balanced flight, preventing drift.

During the round-out, the wing down method is applied. The aeroplane's nose is aligned with the runway through smooth rudder application and sufficient aileron into wind used to prevent drifting off the centreline.

Unless a strong crosswind exists this should not require full or even large control deflections. If large amounts of aileron are required to maintain the centreline, then it is unlikely that rudder effectiveness will be sufficient to keep straight throughout the landing roll. In this situation, unless rudder effectiveness can be improved with an increase in speed, a go-around should be carried out and an approach with a different speed/flap configuration conducted. Alternatively, the runway's suitability may need to be reconsidered.

The landing is made on the windward wheel, which will create a couple that lowers the other main wheel. The rudder is centralised and the nosewheel lowered rather than held off, and some weight maintained on the nosewheel for directional control. At the same time, aileron into wind is increased as the speed reduces.

Throughout the landing a small amount of power (1200 RPM) may be used to improve control and the throttle closed at touchdown.

Keep straight on the runway centreline by reference to a point at the far end of the runway and apply differential braking as required.

No more than neutral elevator should be used to put some weight on the nosewheel so as to avoid wheel-barrowing.

Airborne sequence

On the ground

Ensure that the student places the controls in the right position, allowing for wind.

The exercise

By now, the student should be well practised in the circuit procedures. However, for the crosswind landings you will need to demonstrate, follow through, talk through, and then allow the student to practise with decreasing input from you.

Where practical, the student should be gradually introduced to crosswinds of increasing intensity, commensurate with skill, including experiencing the various speed/flap configurations appropriate for varying wind conditions.

Do not combine a flapless and crosswind landing at these early stages, but it is still possible for the student to practise the emergency procedures previously covered.

After flight

You can tell the student that this is the end of the briefings before their first solo, and that all flights from now until then will be making sure that they know the checks and procedures, and working towards being able to complete the circuit on their own.

Crosswind circuit

Objectives

- To correctly position the aeroplane controls while taxiing.
- To compensate for drift throughout the circuit.
- To take-off and land in crosswind conditions.

Considerations

On the ground

- Aeroplane has tendency to weathercock into wind
- Position controls to compensate for wind

On take -off

- Allow for drift to track along the runway centreline

In the circuit

- Allow for drift and headwind/tailwind on each leg
- Base leg will be affected the most

On landing

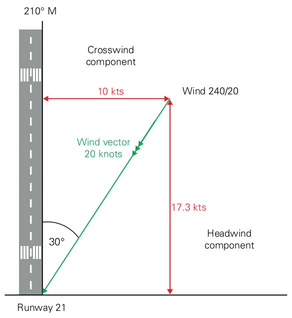
- As crosswind increases amount of flap used decreases – to improve directional control
- More airspeed needed if gusty conditions
- Need to consider overall suitability of runway in crosswind conditions

Maximum demonstrated crosswind

- In Flight Manual
- Limited by ability of rudder and aileron to control aeroplane
- For this aeroplane is ______ kts

Calculating crosswind component

- Need W/V from TAF or METAR
- Convert the direction to magnetic – apply variation
- Vector diagram
- Need pencil, paper, ruler and protractor



Flight Manual graph

Nav computer

Windsock

Tower

Formula

- Angular difference between wind and RWY

Plot on watch face

- Percentage of distance around watch face x wind strength = X/W component
- 30° = half wind strength,
  60° = full wind strength

Air exercise

Take-off

- Line-up, adjust reference point for drift
- Ailerons fully into wind, elevator neutral
- During take-off roll reduce aileron to neutral by rotate point
- Lift off at slightly higher speed than normal
- After lift-off make a gentle balanced turn into wind

Circuit

Climb-out

- Wings level, in balance
- Adjust heading to track extended centreline

Crosswind

- Reference heading allows for drift
- Expect some headwind or tailwind

Downwind

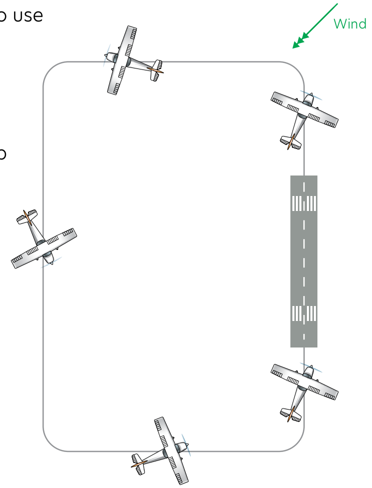
- Allow for wind on downwind turn
- Track parallel to runway
- Assess runway and decide on speeds and flap setting to use
- Check downwind spacing

Base

- Allow for drift and headwind or tailwind
- Extend all the landing flap
- Anticipate turn onto final

Final

- Track extended centreline
- Power controls rate of descent



Landing

- Combination of kick straight and wing down methods

Kick-straight

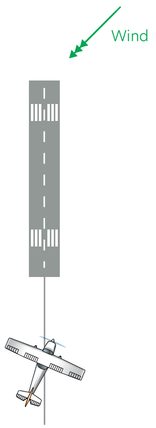
- Crab into wind
- Just before touchdown, kick straight, aileron to keep wings level

Wing-down

- From short final
- Wing held down, rudder to keep aligned with centreline – sideslip
- Land on into wind wheel first

Combination

- Crab into wind on final
- During round-out switch to wing down method
- Aileron to stay aligned with centreline, rudder to stay straight
- Into wind wheel touches down first



Airmanship

- Making the calculations improves SA
- Max crosswind is a recommendation, but may be other limits

Aeroplane management

- Control position on ground wrt wind
- May need to use brakes

Human factors

- Assessing runway suitability improved ADM

Glide approach

This lesson teaches the student to land the aeroplane without engine power. Initially, this is taught as part of the circuit lessons, but is equally important in the forced landing without power lessons.

From a position of about 1000 feet AGL downwind, the students must be able to reach the 1/3 aim point, preferably without flap. Once a landing is assured various methods are used to reduce the L/D ratio and increase the rate of descent so as to touch down as near to the threshold as practical.

Objective

To complete a landing without engine power from the 1000 foot downwind position.

Considerations

There are a number of factors that will affect the ability of the aeroplane to reach the 1/3 aim point. Once it is assured that the aeroplane will reach the 1/3 aim point, the aim point is moved towards the landing threshold, generally by applying flap, so as to use all the available landing distance.

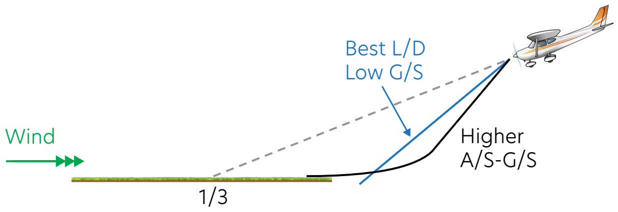
As this exercise will be practised on the home aerodrome, the student should be encouraged to initially aim 1/3 of the way into the runway. Once they are more proficient, the distance available can be progressively reduced by requiring them to stop before an arbitrary point on the runway.

Headwind on final

If it becomes apparent that a stronger than expected headwind on final is causing the aeroplane to undershoot (aim point moves up the windscreen), it may be necessary to lower the aeroplane's nose and increase the airspeed. This will increase the groundspeed, allowing the aeroplane to better penetrate into the wind. This is one of the reasons for aiming 1/3 into the field and delaying flap (see Figure 1).

Figure 1

Headwind on final

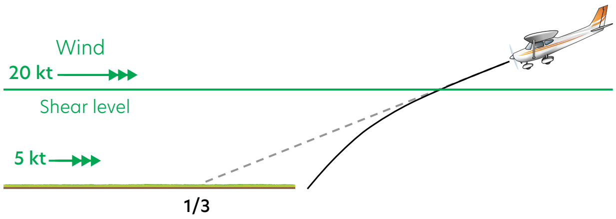


Windshear on final

The only method of countering windshear when no power is available is to increase airspeed. Aiming 1/3 of the way into the field provides a buffer against this eventuality and is also another reason for delaying the use of flap (see Figure 2).

Figure 2

Windshear on final



Moving the aim point

Assuming that the 1/3 aim point can be easily reached from about 500 feet AGL, the L/D ratio is reduced by:

Flap

Flaps are the first option for increasing the rate and angle of descent, because they increase the drag very effectively.

Airspeed

Increasing the airspeed is recommended, by relaxing backpressure, not by pushing the control column forward. This method, however, is not particularly effective when used on its own.

When combined with flap, only a small increase in airspeed will be required to dramatically increase the rate of descent. However, the increase in airspeed means the aeroplane will float in the round-out, so if it is used, it should be used early rather than late. After round-out the airspeed will rapidly dissipate due to the high drag produced by the flap.

S-turns

An S-turn not only increases the total distance to touch down, but also decreases the L/D ratio, as a result of the increased drag generated in the turn. In the modern low-drag training aeroplane this method is not particularly effective.

It should be noted that excessive use of S-turns indicates poor judgement and a poor forced landing plan. It should not be used as a standard manoeuvre, but as a compensation for a judgement error. Most commonly an S-turn is used when the final track has been overshot and some height needs to be lost.

Sideslip

A sideslip is an unbalanced manoeuvre, where the controls are ‘crossed’. For example, right aileron is applied in conjunction with left rudder to prevent the turn or to keep straight.

Due to the comparative ineffectiveness of the rudder in most modern training aeroplane types, full rudder will be required to keep straight, even in a relatively shallow banked sideslip.

Once again, in the modern low-drag light aeroplanes, this manoeuvre is not particularly effective unless it is combined with the use of flap.

Some aeroplanes have a restriction against sideslipping with flap down (refer Flight Manual). This is generally because the flap blankets the tailplane in a sideslip, destroying the airflow over the tailplane. In most cases, where the tailplane normally provides a down load this results in an abrupt nose-down pitch and total elevator ineffectiveness. Although the pitch down ceases when the rudder is centralised (sideslip is stopped); this is an undesirable characteristic, especially near the ground.

If this manoeuvre is not restricted, it is vital that airspeed is increased or at least maintained. If the aeroplane were permitted to stall in this configuration (controls crossed) a spin is almost inevitable.

If sideslipping with flap is permitted, the resulting rate of descent is usually very impressive. When the student first sees the ground rushing up, there is a tendency to increase backpressure to arrest the high sink rate rather than decrease the amount of rudder being used. Therefore, if this manoeuvre is to be used it should be taught at altitude before this lesson (refer CFI). It is also more appropriate to use sideslip in the base leg rather than when close to the ground.

The factors affecting rate of descent should also be applied in the above order, flap first, then increase airspeed, so that a safe margin over the stall speed is maintained during the following manoeuvres, then S-turn or sideslip.

Airmanship

This is only a simulation and the safety of the aeroplane and crew are paramount. Therefore, power should be used at any time the safety of the aeroplane is in doubt, or on the “go-around” instruction.

Glide approach practice must, however, be treated with some seriousness and the importance of a successful outcome stressed.

Plan the glide approach practice with consideration for other traffic, as the exercise does not entitle you to right of way. At controlled aerodromes, it may be appropriate to request a “glide approach” so that ATC can sequence following traffic.

The effects of up-slope and down-slope on approach judgement are discussed.

Consistent with good aviation practice, no passengers should be carried during glide approach practice.

Aeroplane management

Whenever the engine is at idle the carburettor heat should be HOT.

Human factors

Visual limitations in relation to optic flow rates and depth perception, as a result of the high descent rates are discussed.

Air exercise

Confirm spacing and configure the aeroplane late downwind. Reduce power, maintain height, apply carburettor heat early, and trim in preparation for the glide attitude.

In the 1000-foot area abeam the threshold, confirm the throttle is fully closed and the base turn started, considering factors discussed above to achieve 1/3 aim point.

The approach is judged by reference to the 1/3 aim point, down to about 500 feet AGL. At this point the question is asked, "Can the 1/3 aim point be easily reached?".

Yes	No
Manoeuvres to reduce the L/D ratio are applied where necessary in sequence and combined to modify the touchdown point.	Delay the application of flap until the answer is a positive yes.

Airborne sequence

On the ground

Nothing new in here, just perfecting ground operations.

The exercise

Use the full length of the runway available as it makes the demonstration of how easily height can be lost (but not regained) much clearer.

For most aerodromes, choosing an aim point 1/3 into the field will result in the aeroplane being excessively high in relation to the threshold.

This is the whole point of the 1/3 aim point. There is no possibility of the aeroplane being flown through the first fence. When the chosen landing site is shorter, the 1/3 aim point is still 1/3 of whatever length is available, and the possibility of flying through the first fence remains constant. Only the possibility of overrunning the far end of the landing site increases.

From this excessively high position, most or all of the various methods of increasing the rate of descent can be demonstrated.

Once the forced landing lessons have been completed, more realistic field lengths can be simulated by restricting the amount of runway available, for example, from the threshold to the 300-metre (1000-foot) markers. In this case the 1/3 aim point will be about 100 metres in, and only those manoeuvres that are required (in sequence) will be used to modify the actual touchdown point.

The countering of strong headwinds and windshear, by maintaining the 1/3 aim point to about 500 feet AGL and then increasing airspeed, are demonstrated and experienced when conditions permit.

If the aeroplane is low, or more commonly high or fast at the threshold, and the ability to make a safe landing is in any doubt whatsoever – carry out a go-around. During the subsequent go-around, remind the student that maximum braking was still an option (if it would have stopped the aircraft in the space available). Do not put the aeroplane in a position where maximum braking has to be used during a simulation.

Although during an actual forced landing the aeroplane may be forced onto the ground so as to apply maximum braking, during the simulation a normal landing is carried out with brakes as required.

After flight

Let the student know that there will be lots more practice of this manoeuvre and will serve to complete the forced landing lessons.

Glide approach

Objective

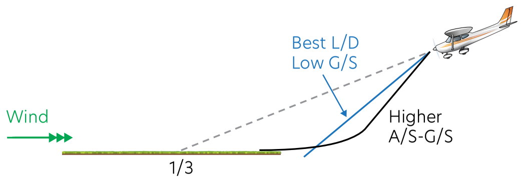
To complete a landing without engine power from the late downwind and 500-foot area.

Considerations

Headwind on final

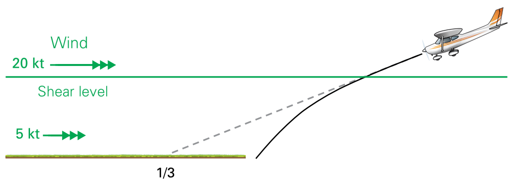
If aim point moves up windscreen (undershooting):

- Increase airspeed – better penetration of headwind



Windshear on final

- Only method available to deal with windshear is to increase airspeed



Moving the aim point

Assuming the $^1/_3$ aim point can be reached, move touchdown point towards you by changing L/D ratio using:

Flap

- Increases drag

Airspeed

- Reducing airspeed could lead to stall
- Increasing airspeed can lead to float at round out

S-turns

- Increases distance
- Decreases L/D ratio

Sideslip

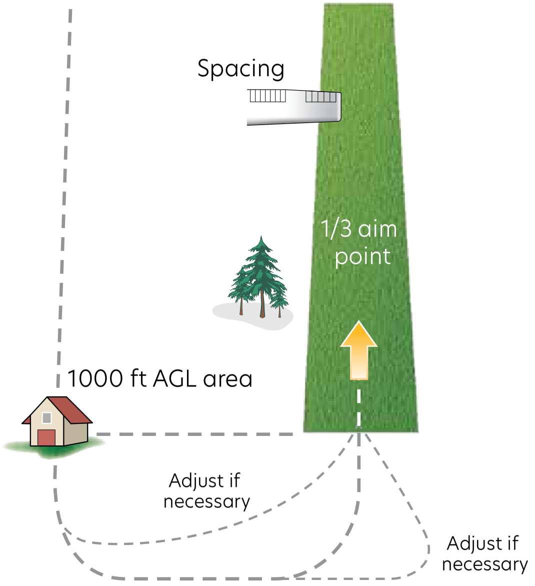
- Aileron and rudder in opposite directions (roll in/yaw out of turn)
- Not very effective in modern aeroplanes, better if combined with flap
- Some aeroplanes have prohibition on sideslipping with flap
- Caution – maintain airspeed

Air exercise

- Confirm spacing, configure late downwind
- Carburettor heat, reduce power, maintain height, and trim
- 1000-foot area close throttle start base turn
- Reference $^1/_3$ aim point to about 500 ft AGL

"Can the $^1/_3$ aim point be easily reached?"

Yes	Make manoeuvres to reduce the L/D ratio, where necessary, in sequence and combined to bring the touchdown point closer to the threshold.
No	Delay the application of flap until the answer is a positive yes.



Airmanship

- Aeroplane safety in doubt – go around
- Not automatic right-of-way
- No pax
- Adjustments for slope

Aeroplane management

- Carb heat HOT
- No engine warms

Human factors

- High rate of descent – optical illusions

Vacating and joining at aerodromes

This lesson covers vacating and joining at controlled and uncontrolled aerodromes.

The standard overhead join procedure is the preferred/default method for joining the traffic circuit at an unattended aerodrome, where no other method is published. It is used when the pilot-in-command needs to assess the runway in use, familiarise themselves with the aerodrome traffic and conditions, or when required by ATC.

The *Standard overhead join* posters are a good resource for this briefing. You can request copies by emailing publications@caa.govt.nz.

Objectives

To vacate and join the circuit in accordance with applicable procedures.

To join an uncontrolled circuit in accordance with the standard overhead join procedure.

Considerations

Discuss vacating the uncontrolled aerodrome first. As with many aspects of safe flying, ground preparation is key to less pressure for the pilot in the air. With a clearance, these methods are also available at controlled aerodromes.

Be aware that helicopters may either conform to the circuit "or avoid the aerodrome traffic circuit being used by an aeroplane operating on or in the vicinity of the aerodrome". Therefore, they will either be sequencing in the pattern, or joining in a manner to prevent conflict with existing traffic. (CAR 91.223)

This rule also exempts agricultural aircraft performing an agricultural operation from conforming with the circuit pattern, but only when a ground symbol is used to indicate this.

The standard overhead join provides a predictable procedure for aircraft (both NORDO and radio equipped) to join the circuit with situational awareness of each other's movements.

Uncontrolled aerodromes

Vacating

Leaving the circuit at an uncontrolled aerodrome is usually done from one of the circuit legs, climbing straight ahead on the runway heading, or from crosswind or downwind, or climbing to overhead – remembering that turns are always in the circuit direction. If intending to turn other than the circuit direction, you need to fly clear of the circuit (2 NM or greater than 1500 ft AGL) before making the turn.

If operating a high-performance (speed or climb) aircraft with traffic joining that may be about to cross the upwind threshold, it is best to delay the take-off. Alternatively, manage the climb to pass through the upwind threshold below 1000 ft AGL clear of joining traffic.

Standard overhead join

Rule 91.223 *Operating on and in the vicinity of an aerodrome* requires the pilot to "...observe other aerodrome traffic for the purpose of avoiding collision, and, unless otherwise authorised or instructed by ATC, conform with or avoid the aerodrome traffic circuit formed by other aircraft." The standard overhead join procedure is the recommended means of complying with this rule, by being 500 feet above aerodrome traffic and then sequencing appropriately.

At an unattended aerodrome there will be no ATC instructions, and there may be no ATIS or AWIB to forewarn the pilot of the runway in use and wind conditions.

If the aerodrome is listed in *AIP* Vol 4, circuit direction will be shown on the aerodrome chart. All circuit directions are left hand unless a curved right-hand arrow is displayed at the threshold depicting a right-hand circuit. This information and an estimate of the surface wind can provide a clue to the circuit direction.

Even if the runway in use is known, the pilot should carry out the standard procedure if they are unfamiliar with the aerodrome layout and unsure of the location of other traffic.

The term 'overhead' is used because the aircraft is flown over the aerodrome at a safe altitude above the circuit to look down and determine which runway is in use, or most suitable, to sight any traffic, and manage the safe sequencing with existing traffic.

It's important to realise that there may be traffic without a radio, NORDO (non-radio), and your only method of avoiding collision with them is to sight them and work out what they are doing from their position and movements. That is why both NORDO and radio equipped aircraft must conform to predictable, standard procedures, including right-of-way rules, ensuring a high level of situational awareness and the ability to sequence without causing conflict.

Discuss the information found on the aerodrome chart that is applicable to the standard overhead join procedure. This includes: aerodrome elevation; runways available and their suitability; circuit directions; specific aerodrome instructions; the location of windsocks; and how to hold the chart to aid orientation. If the aerodrome is unfamiliar to the student, a study of the aerodrome chart should be carried out before flight.

Unless otherwise stated on the aerodrome chart, the standard overhead join is generally the joining procedure used by NORDO traffic.

If the aerodrome chart includes a parachute landing area symbol, caution should be exercised, because most landing charts where parachuting takes place advise against the use of a standard overhead join. This is also a factor where glider winching occurs.

In both cases, when approaching the aerodrome, anticipation of using a standard overhead join procedure is appropriate. If on making a joining call it becomes apparent that parachuting or winching activity is in progress, then the runway in use may be advised or is clear. In such cases it is then prudent to join downwind, base or final. If you arrive overhead without indication of either activity, then situational awareness by all parties should permit completion of the overhead join to at least the downwind position before parachutes or gliders are launched.

Discuss the requirement to terminate the flight plan with ATC after landing at uncontrolled aerodromes.

Simulating a standard overhead join by 'walking and talking the pattern' beforehand can be useful to prepare the student for this exercise.

If the cloud base prevents an overhead join, then still approach the aerodrome with the field on your left, but remain clear of the circuit by positioning greater than 2 NM out and flying around the circuit pattern looking to your left to confirm the wind and ascertain any traffic before joining on either the downwind, base or final leg.

Controlled aerodromes

Vacating

When vacating a controlled aerodrome, all of the previously mentioned options are available. In addition, a clearance to turn in the opposite direction to the published circuit may be given by ATC, or requested by the pilot. If a non-standard clearance is required, keep a good lookout and request it before take-off.

Joining

When joining at a controlled aerodrome, the pilot-in-command has the option of requesting a standard overhead join. This is a good idea if the pilot is unfamiliar with the aerodrome layout, the active runway, or the position of the various circuit legs. ATC also has the option of instructing the pilot to carry out a standard overhead join.

However, the most common method of joining at a controlled aerodrome is to be cleared by ATC to join on the downwind, base, or final approach legs. Such a clearance may be for an aerodrome traffic circuit opposite to the published circuit for that runway; for example, "join right base" for a runway with a left-hand circuit.

Another possible clearance is to "cross overhead and join downwind". This is not a standard overhead join.

It's good aviation practice to establish the aircraft on an extension of the circuit leg to be joined, well before reaching the circuit area.

Where ATC is in attendance, but ATIS is not available, common practice is to request joining instructions. ATC will inform the pilot of the conditions and clear the pilot to join the circuit in the most appropriate way.

When ATIS information has been received before reaching the reporting point for circuit joining, the pilot should state or request from ATC the preferred method of joining.

A clearance to join downwind, base, or final does not absolve the pilot from giving way to other aircraft already established in the circuit.

Aerodrome Flight Information Service

Where an aerodrome flight information service (AFIS) is provided, joining and departing procedures specific to that aerodrome will apply. This may include the standard overhead join.

When joining at an aerodrome with AFIS a radio call at 5–10 miles (or a position determined by the airspace) is required to state your position, altitude, intentions and POB. The AFIS will advise the ATIS, QNH and traffic information. The arriving aircraft then advises more specific intentions based on the information received.

Airmanship

Preparing the aeroplane for arrival involves the use of *AIP* Vol 4, the VNC (Visual Navigation Chart 1:250 000 or 1:125 000 if applicable) and joining checklists.

Revise CAR 91.229 right-of-way rules and emphasise the requirement to make turns in the circuit direction.

Good airmanship dictates that wind awareness is always important. Continually observing any available wind cues, least of all drift, should mean that before joining, the wind can be reasonably anticipated.

If a downwind leg will not be flown, the aeroplane is prepared for landing before circuit entry by using joining and prelanding checks.

There is a tendency for the student to rely on radio calls during the overhead join, and to make too many. It is critical that a good lookout is carried out to identify all aircraft operating in the circuit, including those without radios.

The overhead joining procedure is used to determine the runway in use, and the position of traffic, in order to sequence safely. It does not presume a right of way over existing circuit activity. It may be necessary to remain in the overhead pattern, 500 feet or more above circuit height, until safe sequencing is available.

If potential conflict with other overhead traffic is likely, vacate the overhead and continue (wings level) to a point beyond the circuit area (approximately 2 NM) and turn left to return to overhead the aerodrome at or above the joining height to reassess.

When joining at an unattended aerodrome where an IFR approach may be conducted, it is important to understand and apply the right-of-way rules. If the IFR aircraft is not visual, it will be descending in cloud and be unable to see you or amend its position. It will typically call at least 4-8 NM out as "on long final" which means if you are downwind it would be prudent to extend until you sight the aircraft when it becomes visual.

Aircraft management

Before entering the circuit, the aircraft's speed will need to be reduced to below 120 knots, where applicable, as circuit speeds are normally restricted to this.

The landing light should be on.

Joining checks should be completed.

Human factors

As the student is positioning overhead, encourage them to get oriented by using the aerodrome chart and wind socks for indications of runway in use.

The limitations of vision are revised in relation to closure rates and objects that do not produce relative movement.

There is a lot of information to take in while approaching and circling overhead. Encourage the student to approach it systematically.

Build and maintain situational awareness of other traffic, including surface activity and runway conditions.

Air exercise

Vacating

Discuss the way you would normally vacate your home aerodrome circuit, and the way you would vacate other types of aerodrome.

Uncontrolled aerodrome joining

When joining at an unattended aerodrome, a radio call addressed to the circuit traffic is made between 5 and 10 NM from the aerodrome, stating your position (using VRP, prominent feature, or distance and compass direction), altitude, and intentions. If the first call is made some way out, it may be prudent to make a second call closer in as aircraft on the ground may have just started up and not heard the first call.

The standard overhead join procedure is carried out in three main phases.

Standard overhead join

Approach

Approach the aerodrome to cross overhead at not less than 1500 feet above aerodrome level (refer landing chart) unless otherwise stated on the landing chart; for example, at Palmerston North 1500 feet AMSL is used because of airspace above.

When calculating the altitude to join overhead at, round up – assuming there is no overlying airspace restriction. For example, if aerodrome elevation is 150 feet, join altitude would be 1650 or 1700 feet, not 1600 feet. The reason for rounding up is to maintain a 500-foot buffer over aircraft in the circuit, which may have rounded up the circuit altitude. At altitudes above 1500 feet, it is harder to distinguish the windsocks, and more altitude will need to be lost on the descent. In addition, if all aircraft join at the same altitude it should be easier to see each other.

Effort should be made to identify the wind before arriving at the aerodrome by observing cues such as drift, wind shadow on stationary water, trees, smoke, dust, forecast wind, etc, to anticipate the into wind vector.

On approach, position the aircraft with the aerodrome to the left, so that the student can look out of their window, down and across the whole aerodrome, observing traffic, windsocks and ground signals or markings.

Determine runway in use

Firstly, the student must determine (if aware of the wind direction, then confirm) which runway is in use, as this sets which direction to make all turns, and the traffic and non-traffic sides.

The runway in use can be worked out by observing the windsocks, or other traffic already established in the circuit. If the runway in use cannot be determined, make a turn to the left and remain in the overhead pattern until it is determined. If it is then found that a right-hand circuit is in use, continue to the non-traffic side positioning to make all further turns to the right. If a right hand pattern is required, depending on existing traffic, either veer left on crossing the threshold to allow sufficient room during the turn to the right to descend to circuit height before again crossing to the traffic side, or fly wings level clear of the non-traffic side to reposition in a right pattern.

Note that windsocks are generally sited on the left near the threshold of each vector. On smaller airfields, if there is only one windsock it will generally be centrally placed. If there are crosswind vectors without windsocks at each end, again there will generally be a centrally sited windsock.

If potential conflict with other overhead traffic is likely, vacate the overhead and continue (wings level) to a point beyond the circuit area (approximately 2 NM) and turn left to return to overhead the aerodrome at or above the joining height to reassess.

Be aware that some aerodromes have alternate circuit patterns for helicopter and glider traffic. If they are in use, joining aircraft must sequence into the circuit without causing conflict.

Both the traffic and non-traffic side must be identified to avoid descending onto aircraft already in the circuit. One method of identifying the traffic side is to have the student imagine they are lined up on the chosen runway ready for take-off. If they were to take-off which way would they turn at 500 feet – this establishes the traffic side.

Once the runway in use has been established and the circuit direction is confirmed (refer landing chart), a turn is made in the circuit direction to position the aircraft on the non-traffic side. As aerodromes are potentially areas of high traffic density, use no more than a medium angle of bank. At this point it is good aviation practice to make a radio call advising traffic of the runway you are joining for.

Aircraft already in the circuit have right of way. This means that if aircraft in the circuit are using a runway considered unsuitable for your operation, the responsibility of avoiding conflict is on the joining aircraft, even if the runway in use is out of wind.

Regardless of which way the aircraft is turning, the turn is continued until the centreline of the runway in use is crossed, and the aircraft enters the non-traffic side. To enhance a good lookout, have wings level sections in the overhead rather than a continuous turn.

Avoid giving too much attention to ground features during these phases, maintaining a lookout for other aircraft is more important as NORDO aircraft will not be heard and must be seen.

Additionally, look for gyrocopters, helicopters or gliders that may have a closer-in circuit than you expect. Likewise, high performance aircraft such as twin-engine or warbirds may operate a wider circuit.

Descend to circuit height

When established on the non-traffic side, descend to circuit altitude. A low rate of descent is preferred because of the potentially high traffic density around an aerodrome. Common practice is to use a cruise or powered descent.

The aircraft crosses onto the traffic side over the upwind threshold at circuit altitude. That provides the longest possible downwind leg, while at the same time still providing maximum vertical separation from high-performance aircraft taking off, or an aircraft that may be conducting a go-around. This is predictable positioning for everyone's situational awareness.

As the downwind leg will be shorter than normal, the pre-landing checks can be completed during the descent on the non-traffic side or on the crosswind leg (refer CFI).

On this crosswind leg, correct for drift, in order to track at right angles to the runway. A good lookout will need to be maintained for aircraft flying on the downwind leg. Do not turn in front of any such aircraft – always position behind.

The downwind radio call is made as soon as the aircraft is established on the downwind leg, and the circuit is completed in the normal manner.

Controlled aerodrome joining

The standard overhead join can be carried out at controlled aerodromes with a clearance from ATC. More normally you will join via one of the circuit legs, usually downwind or via base leg.

Consult *AIP* Vol 4 for differences, particularly where there are neighbouring aerodromes.

Airborne sequence

On the ground

Make sure the student has all the necessary information to hand, and they have briefed themselves on the landing chart.

The exercise

Vacate the circuit as cleared by ATC, or the way you discussed in the briefing.

The student will have already seen in previous lessons how to vacate the circuit, but you may need to prompt some of the radio calls.

If you will be using your home aerodrome for the standard overhead joining procedure, head away in an unfamiliar direction, to add a little realism.

Begin the exercise between 10 and 5 NM from the aerodrome, over a local feature or VFR reporting point.

Talk through the standard overhead join procedure, and then have the student practise before any solo practice.

From the downwind leg, an approach and landing or go-around can be carried out before vacating the circuit for student practice. If this is your home aerodrome, you may elect not to do the landing, instead taking the opportunity to practise a go-around. If it is an unfamiliar aerodrome, however, landing practice would be beneficial.

It is advisable for the student to experience approaches from different directions and to different vectors before conducting solo practice.

After flight

There probably won't have been time to cover every method of vacating and joining the circuit, so advise the student that you will take the opportunity in future lessons to practise these different methods.

Vacating and joining at aerodromes

Objectives

- To vacate and join the circuit in accordance with applicable procedures.
- To join an uncontrolled circuit in accordance with the standard overhead join procedure.

Considerations

Uncontrolled aerodromes

Vacating

- Climb straight ahead to 1500 ft
- Via crosswind or downwind
- Climb overhead
- All can be done from controlled aerodrome – with clearance

Standard overhead join
(consider possible parachute and winching activity)

- Used
  - To keep clear of the circuit until safe to join
  - To observe other traffic, including NORDO
  - To identify circuit direction
  - To determine conditions on the aerodrome – wind, surface, etc
  - When unfamiliar with the aerodrome
- Check aerodrome chart in *AIP* Vol 4 in preparation
- Terminate flight plan once on the ground

Controlled Aerodromes

Vacating

- Same as uncontrolled, but clearance is needed
- With clearance, could turn opposite to circuit direction – good lookout

Joining

- Can request overhead join
- Normally join downwind, base, or final
- Could also "Cross overhead and join downwind"
- Can request joining or may be given joining instructions
- Must still give way to those already in circuit

Air exercise

Vacating

- From home base
- From (un)controlled aerodrome

Uncontrolled aerodrome joining – standard overhead join

- Radio call to circuit traffic 5–10 NM from aerodrome
  - position
  - altitude
  - intentions

Approach

- Cross overhead at 1500 ft AGL (if no other restrictions)
- Position aeroplane so aerodrome can be seen out of student's window
- Look for other traffic, windsocks, and ground signals/markings

Runway in use

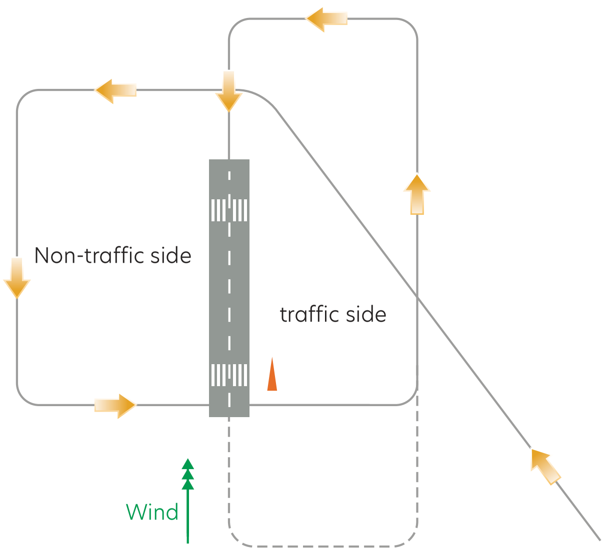
- Look at windsocks, and other traffic established to establish circuit direction
- If can't tell circuit direction continue left until can tell
- Watch out for helicopter or glider circuits
- When circuit direction established,
  - all turns in that direction
  - Identify traffic and non-traffic sides
- Position on non-traffic side, make radio call
- Others already in circuit have right of way

Descend to circuit height

- Low rate of descent
- Cross upwind end of runway **at** circuit height
- Track crosswind – give way to aircraft already on downwind leg
- Prelanding checks before downwind
- Downwind call on downwind leg
- Rest of circuit as normal

Controlled aerodrome joining

- In accordance with ATC clearance or instructions



Airmanship

- Vol 4, VNC, joining checklists
- Right-of-way rules
- LOOKOUT, don't rely on listenout
- Wind awareness

Aeroplane management

- Speed below 120 kts
- Landing light on

Human factors

- Orientate using windsocks and aerodrome chart
- Relative movement of small objects
- Systematic approach best

Radio failure

Although modern aeroplane radios are reliable, the student needs to know the procedure to follow in the event of a communications failure. It's recommended that once the standard overhead join procedure has been mastered by a student, simulated radio failure procedures should be taught before any solo exercises in the training area.

When the student's home aerodrome is controlled, the CFI will provide guidance on what the student should do in the event of a radio failure outside the circuit. The exercise can be simulated if arranged with ATC in advance, and outside peak times.

However, if a diversion is required, training in this procedure will need to be given before solo exercises outside the circuit.

Objective

To join at a controlled or uncontrolled aerodrome in the event of a radio failure.

Considerations

Legally, an aircraft cannot enter a control zone without a clearance, so should the student break this rule or divert? Generally, ATC can be expected to accept an aircraft returning to the controlled aerodrome under these conditions, especially if the transponder code 7600 is used.

If a clearance to enter the control zone has been received before the failure, then continuing in accordance with the clearance is what will be expected. If the clearance did not specify a method of joining, a standard overhead join may be the best option, as ATC will be able to predict the aeroplane's movements.

If a radio failure has occurred, it is unlikely to be detected until an attempt to make contact is initiated. For example, when tuning into the ATIS, or when requesting joining instructions. In the case of an uncontrolled aerodrome, where position and intentions only are transmitted, it may not be detected at all.

The general causes of communications failure are:

- wrong frequency selected,
- on/off and volume switch turned down,
- the aeroplane altitude too low and/or range too great,
- alternator failure (although battery power should still be available and the alternator failure detected by other means),
- comm box switches not selected to headphones,
- avionics or master switch accidentally selected off,
- radio loose in its cradle,
- faulty headset connections, or
- a popped circuit breaker.

Check for simple solutions first, by recycling – or turning on – master switches or avionics selectors.

Many modern radios can be tested for signal reception by selecting the test function and signal transmission confirmed by the small 'T' illuminating when the press-to-talk switch is depressed.

Airmanship

Anticipate what the wind is likely to be, and therefore circuit direction.

Preparing the aeroplane for arrival involves the use of *AIP* Vol 4, Visual Navigation Charts (VNC), and joining checklists.

Revise the importance of using eyes and ears to lookout. Using the 20 degree per 2 second visual scan technique and listening to radio calls (if available) builds situational awareness, and the student should be able to identify aircraft by both means.

The right-of-way rules are revised, and the requirement to make turns in the circuit direction emphasised.

Terminate your flight plan with ATC after landing.

Aeroplane management

Before joining the circuit, the airspeed should be reduced to below 120 knots and landing lights turned on.

Human factors

Information processing limitations and the use of mental models to retain situational awareness will help the student to draw a mental picture of the position of reported traffic.

Air exercise

With a communications failure established, refer to *AIP New Zealand* Emergency Section for the procedure to follow. Obviously it will be of some benefit to the student to have read this section before an in-flight communications failure.

The main points of this procedure are:

- transmit blind (as all normal calls will be made, this action can be simulated)
- squawk 7600 (touch)
- turn on all lights
- use a cellular phone to communicate if available.

Once a radio failure has been identified, the student should be instructed to aviate and navigate – remaining clear of controlled airspace, while a possible cause of the problem is investigated.

From the CFI's determination of the procedure to follow in the event of a radio failure, choose from the two options below.

Uncontrolled aerodromes

The join procedure is exactly the same as the standard overhead join, except that transmissions should be made 'blind'. A keen lookout for other traffic should be emphasised. If in any doubt, return to circle overhead at 1500 feet.

Radio failure is simulated and the trouble-shooting sequence or checklist carried out. Completing this sequence gives the student practice in prioritising Aviate – Navigate – Communicate, and often demonstrates the limitations of information processing and the effects of stress. It is recommended that the student be given adequate practice in systems knowledge and fault detection on the ground, before flight.

With the radio failure established, the *AIP* Vol 4, VNC, and checklist can be referred to and the communications failure procedure adopted.

Controlled aerodromes

The student will need to know the meaning of the various light signals that will be used by ATC, and how to respond to them.

The meaning of light signals and how to respond is best covered in one of the pre-solo circuit revision briefings recommended earlier. The meanings and response need only be revised here by reference to *AIP* Vol 4.

With the radio failure established, the *AIP* Vol 4, VNC, and checklist can be referred to and the communications failure procedure adopted.

Enter the control zone and carry out the standard overhead join procedure, watching out for the light signals and responding appropriately.

Report the communications fault to the control tower after landing.

Airborne sequence

On the ground

Make sure the student has had time to study the particular communications failure procedures for your home aerodrome, as well as the general procedures from *AIP New Zealand*.

The exercise

Organise with the Tower to show you and the student the light signals.

Simulate radio failure at different times to assess the student's decision-making while operating in the circuit, in the training area, and entering and exiting controlled airspace.

Radio failure

Objective

To join at a controlled or uncontrolled aerodrome in the event of a radio failure.

Considerations

- If controlled, return or divert?
- Clearance required to enter Control Zone
- Follow any clearance already accepted
- If cleared to enter, but no joining instructions – join overhead
- How is it detected?

Causes

- Wrong frequency selected
- On/Off and volume switch turned down
- Altitude too low and/or range too great
- Alternator failure
- Comm box switches, including intercom
- Avionics or master switch accidentally off
- Radio loose in its cradle
- Avionics master off
- Faulty headset connections/control settings
- Popped circuit breaker
- Check simple solutions first

Air exercise

- Be familiar with comms failure procedures in *AIP*
- Transmit blind
- Squawk 7600
- Turn on all lights
- Use a cellular phone to communicate if available
- Aviate – Navigate
- Remain clear of controlled airspace while diagnosing and planning

Uncontrolled aerodromes

- Standard overhead join
- Trasmit 'blind'
- Keen lookout for other traffic
- Refer to Vol 4 and VNC
- Complete checklist

Controlled aerodromes

- Light signals used by tower
- Vol 4, VNC
- Checklists
- Carry out standard overhead join
- Report fault to tower after landing

	Colour and type of signal	To aircraft in flight	To aircraft on the aerodrome
●	Steady green	Cleared to land	Cleared for take-off
●	Steady red	Give way to other aircraft and continue circling	Stop
●●●	Series of green flashes	Return for landing	Cleared to taxi
●●●	Series of red flashes	Aerodrome unsafe – do not land	Taxi clear of landing area in use
○○○	Series of white flashes	Land at this aerodrome and proceed to apron	Return to starting point on aerodrome
●●●	Series of alternate red and green flashes	Danger – be on the alert	Danger – be on the alert
	Red pyrotechnic	Notwithstanding any previous instructions do not land for the time being	

① Circling means continue tracking in the aerodrome traffic circuit. Do not orbit in position.
② Clearance to land and taxi will be given in due course.

Airmanship

- Anticipate circuit direction
- Vol 4 and joining checklists
- Right-of-way rules
- Lookout
- Terminate flight plan after landing

Aeroplane management

- Below 120 kts before joining
- Landing lights on

Human factors

- Use mental picture to help orientation

Advanced manoeuvres

The order of the next twelve lessons will be dictated by conditions on the day. It's expected that the student be sent solo to practise these manoeuvres in the training area on a regular basis between dual lessons. Please refer to your CFI.

Forced landing without power – pattern

This briefing covers the determination of wind direction; the selection of the most suitable landing site; initial configuration of the aeroplane for best gliding performance; and the pattern flown to achieve a successful forced landing. The next lesson, **Forced landing without power – considerations**, covers checks and further decision making factors.

We've already discussed the main reasons for engine failure (fuel, air, spark) in the **Engine failure after take-off** lesson and how sensible precautions can minimise risk – preflight inspection and planning, run-up, checks, safety brief, and SADIE.

In addition, the student is familiar with the need to produce an automatic response in emergency situations, and with the glide approach.

This lesson discusses the ideal procedure to follow in the unlikely event of a total or partial engine failure in the cruise at altitude (above 1000 feet AGL as a guide) where more time is available to plan and consider options than the EFATO. Later exercises will provide practice in adopting this procedure from a lower altitude.

A partial engine failure or rough running is more common than a total failure, but this is still rare. The recommended procedure for dealing with the partial power failure begins with the same steps as a total failure, and therefore the pattern is relevant to both.

A total power failure will be simulated by closing the throttle.

Objective

To be able to select an appropriate landing site and carry out the pattern for a forced landing without power.

Considerations

Configuration

State the configuration required to achieve the best L/D ratio for the aeroplane (_____ knots, no flap and propeller windmilling), and its effect on range. The effect on range of using other airspeeds will be discussed in the next briefing, **Forced landing without power – considerations**.

Although drag is reduced by stopping the propeller, this procedure is not recommended, or required, to achieve the objective of this lesson (refer CFI).

Wind indicators

The various methods of determining the wind speed and direction are discussed, with initial emphasis on direction, because the plan is based on wind direction. Adaption of the plan is needed when wind strength is recognised, and in the latter stages of the plan.

The most relevant indicators are those at ground level: smoke; dust; crop movement; tree and leaf movement; wind lanes; wind shadow on water; and drift.

Smoke

Smoke is a clear indication of wind direction and strength, and rarely available when you need it.

Dust

Dust from dirt roads, river beds, ploughing, or ground spread fertiliser, may indicate wind direction and strength.

Crop movement

Ripples move downwind across the top of crops, especially wheat and hay fields.

Tree and leaf movement

The tops of Poplar-type trees lean with the wind.

Willows, after initial spring leaf growth, indicate wind by showing the silver underside of their leaves in winds of 8–12 knots or more. The silver side of the tree is the windward side.

Wind lanes

Wind produces effects on the surface of water. Light winds, 5–15 knots, can ruffle the surface and, when viewed up or downwind, these disturbances form streaks of parallel lines, indicating the wind direction – but it can be difficult to resolve the 180-degree ambiguity unless wind shadows exist near the shore.

Above 15 knots, the wind may drive spray or foam in parallel lines. These too can be misinterpreted by 180 degrees, although the streaking may be more marked when looking downwind compared with upwind.

Fresh water typically forms whitecaps at 12–15 knots, and seawater at 15–18 knots.

Waves and ripples

Small waves and ripples form at right angles to the wind and move downwind. From altitude, however, it may be difficult to determine the direction of wave movement.

Wind shadow

Wind shadow can be seen at the upwind end of a lake or pond. It's an area of calm water where the shoreline protects the water from the wind, creating an area of calm water. This effect is most noticeable in winds of 5 knots or more, when the sunlight reflects off the water's surface. A small version of this can be seen as you walk out to the aeroplane after rain. Puddles of water will display this same effect when the wind is blowing. Wind shadow is best seen on small ponds or lakes of stationary water, rather than large expanses of water.

Any indication of wind seen in flight should be noted in case it's needed in the future.

Cloud shadow

The movement of cloud shadow over the ground gives the wind direction and some indication of speed, at the cloud level. This is used only as a guide, however, as the wind on the ground will probably be different. Likewise, the 2000-foot wind and area forecasts are only a guide to the wind's general direction and strength. Apply local knowledge and orographic effects to estimate the wind on the ground.

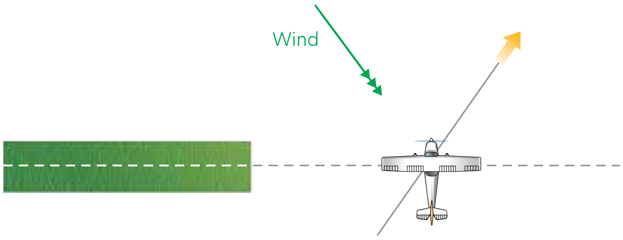
Drift

Drift can be useful, as it's what you are experiencing at altitude, but it takes experience to recognise it correctly. Be aware that it can be induced by flying out of balance.

The pilot needs to develop an awareness of where the aeroplane is heading compared to where it's tracking. When flying across the extended centreline of any landing area, if drift is present it can be seen (see Figure 1).

Figure 1

Drift



Local knowledge

The other means of determining wind direction and strength are related to local knowledge and the aerodrome of departure. Local knowledge includes terrain and local effects, such as anabatic or katabatic winds, sea or land breezes, and how the Aviation Area Winds (AAW) may be affected locally. Relevant conditions at the aerodrome of departure include the 2000-foot wind forecast, the windsock, and the known take-off direction. The usefulness of these indicators is relative to the distance of the aeroplane from the aerodrome – and the intervening terrain.

Choice of landing site

The choice of the most appropriate landing site is usually a compromise and is discussed using the mnemonic, the 'seven Ss, C and E'.

The seven Ss are: size, shape, slope, surface, surrounds, stock and sun. The C is communication and E is for elevation.

Size

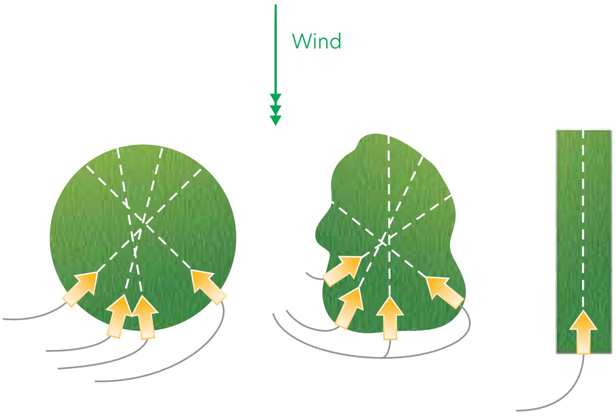
The ideal size is for the longest possible landing area into wind within gliding distance (to be discussed further in the 'considerations' lesson).

Shape

Shape is mentioned because the student may limit their search for a landing site to only those sites that resemble a runway. In fact, the perfect shape is a circle, as multiple approach paths into wind are available. Even a square is preferable in contrast to a narrow paddock with only one approach path (see Figure 2).

Figure 2

Consider all shapes of landing sites



Slope

An uphill slope for landing is preferred over level ground. A down slope should be avoided – it would take a very strong wind to override the disadvantages of a downhill landing. Slope can be difficult to detect at altitude, and when slope is apparent from altitude, generally the terrain is very steep. Water runs downhill, and a dam wall on farm water storage ponds can also indicate downhill slope. Significant 'white water' in any flow indicates significant gradient.

Surface

A firm surface is recommended, not so much for stopping distance, but to avoid the nosewheel digging into the soft surface and somersaulting the aeroplane. Determining the type of surface from altitude can be done by comparing the texture of the local aerodrome's grassed areas with those of various paddocks.

Surface also includes anything on the surface, such as: stock; crops; fences; stumps; rabbit holes; soft or wet patches; undulations; etc.

Surrounds

Where possible, a landing site that has a clear field on the approach and the upwind end should be chosen to provide for undershoot and overrun during the forced landing. For the training exercise, a clear go-around and climb-out path is also considered.

An approach over a road will quite likely bring you into close proximity with power wires running along the road.

Sun

Sun is normally only a problem at sunrise and sunset, particularly in winter. Under these conditions an approach in the direction of the sun may blind the pilot on final. Accepting some crosswind may be better than an approach directly into a low sun.

Communication

All of the previous factors are the priority, but if there is a choice available to land near habitation, especially where there is little of it, it will put you closer to help. For example, if you are over a ridge and to one side is a remote area and the other has habitation – choose the habitation.

Elevation

Based on local knowledge, charts, or comparing the altimeter reading with terrain perspective, the height above sea level of the landing site needs to be estimated. This is because the procedure is planned on heights above ground level but flown on heights above sea level with reference to the altimeter.

The pilot should be able to recognise heights without the use of the altimeter. For example, the circuit height is generally 1000 feet – have the student fix that as a metal picture they can use during this exercise. Do the same for 500 feet and 1500 feet.

Situational awareness

The ability to quickly implement the forced landing procedure is markedly enhanced by good situational awareness. Throughout the flight, the pilot should observe wind indicators and the approximate elevation and suitability of the surrounding terrain.

This does not require the pilot to choose a specific forced-landing site and update it continuously in cruise. By taking notice of their environment the pilot should know where the wind is coming from and where in relation to the aeroplane the more suitable terrain is for a forced landing. Should an emergency develop, an immediate turn toward this area is made and then a specific field chosen.

Choosing a flight path that takes into account the terrain over which the student is flying shows good airmanship.

Airmanship

Revise the checks that will only be carried out by touching the control.

Simulating engine failure

There are at least two methods of simulating the engine failure. Your CFI will determine the organisation's practice. Simulating engine failure in a variety of ways is more likely to expose the student to the real life possibilities, and they are more likely to react appropriately, rather than to just one particular stimulus.

The recommended method is to partially close the throttle, and leave the student to respond by selecting carburettor heat to HOT and closing the throttle.

Another method is to set the mixture to idle cut-off, thereby encouraging the student to close the throttle and apply carburettor heat, as they would in the real situation. If using this technique, make sure the throttle is fully closed before returning the mixture to RICH. This method is not recommended for single-engine aircraft.

Once the student has gained some competence in this exercise you can introduce engine failures with little or no warning – as it would be in the real world.

The simulation is ended with the instruction to "go around", at which point the student is to immediately carry out a go-around. In later lessons more emphasis will be placed on the student's decision making to initiate the go-around without prompting.

It's also important, in later lessons, for the student to complete the exercise through to the landing. This can be completed by conducting the forced landing over an appropriate aerodrome.

Dual forced landing practice qualifies as a bona fide reason to fly below the height prescribed in rule 91.311(a)(2). See rule 91.311(c) for the conditions required.

When practising solo, unless operating in a low flying zone (LFZ), the go-around will be at 500 feet AGL (see CFI for the organisation's limits).

Aeroplane management

As a prolonged climb will be required before starting the exercise, a period of level flight is recommended to allow the engine temperature to stabilise before closing the throttle.

To maintain adequate engine operating temperatures and pressures during the prolonged glide, the engine is warmed or cleared every 1000 feet (minimum) by smoothly opening the throttle to full power and closing it again. This ensures that normal power will be available for the go-around, clears the spark plugs of lead and carbon deposits, and puts warm air through the carburettor preventing ice buildup. If the engine runs rough during the engine warm, consider warming or clearing more often (every 500 feet), delay closing the throttle again until smooth running is achieved, or begin the go-around immediately or at a considerably higher altitude than the minimum. This will depend on the engine's running characteristics and the terrain.

There is no need to select carburettor heat COLD during the engine warm as no attempt is being made to continue using full power. In addition, the effectiveness of the carburettor heat is dependent on engine temperature, therefore, the application of full power will ensure carburettor ice is cleared.

Human factors

Avoid turning your back on the chosen landing site.

Information processing loads are high in this first lesson, but with practice the overload will reduce, and more information can be introduced.

Avoid mindsets by revisiting and evaluating any decisions made, especially those relating to wind.

When conducting the FLWOP exercise, encourage the student to approach all assessments from the perspective of exposure to threats they perceive, as they conduct each element of the exercise.

Air exercise

The exercise starts from an appropriate cruising altitude (refer CFI), not a height above ground level, as the aeroplane is normally flown by reference to the altimeter.

The initial actions, planning and flying the procedure are discussed.

Immediate actions

Apply carburettor heat and close the throttle. Carburettor heat will remedy a real icing problem or prevent one during the simulation. Select alternate air for fuel injected engines.

Convert excess speed to height, since there may be an appreciable difference between the cruise speed and the recommended glide speed. The average training aeroplane may not actually increase height, but at least preserve it.

Set glide attitude and trim. As the best glide speed is approached, allowing for inertia, the attitude is selected for the glide and the aeroplane accurately trimmed to maintain this attitude.

Confirm wind direction and select a suitable landing area. If situational awareness has been maintained, the wind and the approximate elevation of surrounding terrain are confirmed. The aeroplane is turned toward the most suitable area for a forced landing. It should be stressed that – if the student has not been maintaining their situational awareness – valuable time will be wasted while these factors are assessed.

Make the plan. See the notes below on making and executing the plan.

Make a MAYDAY call (simulate only during training).

Trouble checks

When there is time available for diagnosis, as there is during a forced landing, carry out the trouble checks to see if you can get the engine restarted.

F Fuel

- Fuel selector ON, fuel pump ON (if applicable), change tanks (touch).
- Fuel pressure and the contents gauges are checked and compared with the fuel tank selected.
- Some use CCPPP: cocks, contents, pump, pressure, primer.

M Mixture

- Mixture RICH, carb heat HOT, primer LOCKED.
- These are checked and the mixture, in the case of partial power, altered (touch) to see if there is any improvement in power or smoothness.

I Ignition

- Ignition LEFT, RIGHT or BOTH (touch), check temperatures and pressures.
- Trying LEFT (touch) and RIGHT (touch) magneto positions for smoother running may keep the engine running. Try to restart the engine with the ignition key (touch) if the propeller is not windmilling.
- Check the temperatures and pressures for any reading outside the green range.

P Partial Power

- Check.
- Set the throttle to about one third open (refer CFI) to see if any power is available. If no power is available, the throttle must be closed again so as to prevent the engine unexpectedly bursting into life at an awkward moment. In the simulated exercise, the partial power check serves to warm the engine.

The plan

A specific landing site or the best compromise needs to be chosen and the approach planned.

Planning the approach begins with selecting a minimum of three reference points:

- an aiming point 1/3 of the way into the field in the landing direction,
- a 1000-foot AGL area (some prefer a point, refer CFI),
- a 1500-foot AGL area.

The aim is to fly the approach as similar to a left-hand circuit as possible, unless terrain, cloud, obstacles or gliding distance favour a right-hand circuit.

Start selecting the points from the ground up as there is little point choosing a 1500-foot area if you are at 1300 feet.

Stress that the 1000-foot and 1500-foot references are above ground level, and that these provide valuable orientation information if the landing site is lost from view.

Some organisations recommend an additional 2000-foot AGL area (refer CFI).

When the considerations of a right-hand circuit are introduced (refer CFI), the plan is simply flipped over, to produce a mirror image on the right-hand side of the landing site.

Landing aim point

The first step is to divide the available landing distance into three, and choose a definite reference or aiming point at about 1/3 of the way into the field. The logic behind this is that it's better to taxi, even at high speed, through the far fence than to fly into the threshold fence.

Although a positive reference point on the field is best, it does not have to be in the field itself, but can be abeam the 1/3 aiming point, one or two paddocks over.

1000-foot area

The 1000-foot area is at 90 degrees, or right angles to the threshold, usually 3/4 of the normal circuit distance out (refer CFI). This area should be about the size of a football field or four to six suburban residential sections.

There is a natural tendency for the student to hug the field, resulting in a very tight turn to final, and little or no opportunity to adjust the approach. The downwind leg should never be closer than three-quarters of normal circuit spacing.

1500-foot area

The 1500-foot area is a larger area further back from the 1000-foot area.

From anywhere within this area, at 1500 feet AGL, it will be possible to glide to the 1000-foot area and arrive at about 1000 feet AGL.

This area may be over the field if low, or swung out wider than downwind if high, as if the aeroplane is on a string held at the 1000-foot area.

Altitudes

The next step in the planning process is to transform the 1000-foot and 1500-foot areas into altitudes that will be seen on the altimeter, by adding on the estimated elevation of the chosen landing site.

It will be shown a little later how the downwind spacing compensates for any error in the estimate of elevation. A point worth making here is that it's always better to overestimate than underestimate and that if there is any doubt, add two or three hundred feet onto the estimate of the landing site elevation.

Positioning

The most important part of the plan is assessing progress into the 1500-foot area from wherever the aeroplane happens to be.

The ideal procedure starts from the non-traffic side, flying parallel to the chosen landing site to provide a standard reference to which variables can then be applied during later training.

The positioning process is assisted by asking at regular intervals, "Am I confident of reaching the 1500-foot area at _____ feet?". If any doubt exists, a turn toward the area should be started immediately. If no doubt exists, the turn can be delayed.

Reconfirming wind, especially wind speed estimates, by acknowledging drift may result in a plan adjustment, especially in stronger winds.

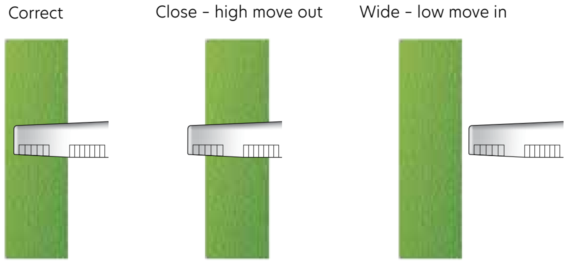
Once the 1500-foot area has been passed, the aeroplane is positioned on the downwind leg.

Spacing

On the downwind leg, it's vital that the spacing is assessed in relation to the nominated point on the aeroplane's airframe to establish the correct circuit spacing. It's this process that compensates for any misjudgement at the 1500-foot area, and any error in estimating the landing-site elevation (see Figure 3).

Figure 3

Spacing in the circuit – an example of how spacing is assessed using the parallel markings on a low wing aeroplane



In a high-wing aircraft, position the 'runway' within the outer third of the strut.

In the classroom, put a piece of paper, representing the landing site, on a desk or the floor and give the student a model aeroplane. Ask them to stand in the downwind position and place the model at the chosen downwind spacing.

By lifting the model aeroplane higher, you can show that the aeroplane is now too close or too high. At the new height the student must move out from the landing site to once again position the airframe feature onto the diagram.

Lowering the model will have the reverse effect (too wide or low) and force the student to move in toward the diagram to re-establish the correct spacing.

At the 1000-foot area, abeam the threshold, the approach phase starts.

The approach

How soon the base turn is started depends on the wind strength. Strong wind, turn sooner. Light wind, turn later.

The base turn can be adjusted but **never extend the 1000-foot area downwind**.

The aeroplane should be turned to track on base leg at 90 degrees to the landing direction.

From the base leg, further adjustments can be made if necessary. If the approach appears too low, the turn onto final can be made early. Conversely, if too high, the base leg can be extended or the turn widened to pass through the centreline.

Throughout the approach, from the 1000-foot area down to approximately 500 feet AGL, continual reference is made to the 1/3 aim point and to maintaining glide speed. No checks are carried out during this segment. The student should be familiar with the glide approach as covered in the circuit lessons.

It's very important to offset drift during the base leg to ensure the aeroplane tracks correctly in relation to the field.

The student should be repeatedly asking, "Can I reach the 1/3 aim point?".

In extremely strong winds, or if a headwind is encountered on base, this may require the aeroplane to be turned to point directly to the 1/3 aim point.

The aim of this process is to position the aeroplane at about 500 feet, so as to touch down at the 1/3 aim point, preferably without flap.

If there's a need to use flap earlier, because you are grossly high, then flap is used. Application of flap in stages is used to bring the actual landing point back toward the threshold from the 1/3 aim point, so as to make maximum use of the length available.

The approach and landing phase of this lesson will be covered in more detail in the following 'considerations' lesson.

Airborne sequence

On the ground

No new material included here. The student should know all of the checks on the ground and be able to take you to the training area with little input from you.

The exercise

During the climb and transit to the training area, point out the various wind indicators and surface types (ploughed, swampy). Encourage the student to evaluate the field type while they are carrying out the go-around. Also, give the student some opportunity to practise estimating the elevation of various landing sites, preferring a rounding-up estimate if in doubt.

Before starting

Before starting the exercise, all available indicators of wind should be observed or discussed, the initial forced-landing site pointed out, and the student asked to estimate its elevation.

The various reasons for choosing the landing site are discussed in relation to the 'seven Ss, C and E'.

The introduction to forced landing without power is never carried out onto an aerodrome or agricultural airstrip. This is because a major part of this exercise deals with assessing the wind without a windsock or known active runway and the suitability of the landing site, which is not a designated landing area. In addition, all aerodromes attract aircraft and have an aerodrome traffic pattern around them, requiring radio calls to be made for the information of other traffic. Even if you carry these out, they form a distraction to the lesson.

The planning process is discussed next, specifically choosing the 1/3 aim point, the 1000-foot area, the 1500-foot area, and how to initially achieve the 1500-foot area.

Throughout this process, the chosen landing site is kept on the left of the aeroplane (student's side) and the aeroplane is held in a gentle level turn so that the landing site can be continually observed.

There are two common errors an instructor can make.

1. Getting too close to the landing site, requiring steep angles of bank or flight out of balance to observe the field. At the heights commonly used to start this exercise, the aeroplane needs to be at least 2 NM away from the field (at least twice circuit spacing).
2. Not allowing for drift during the gentle turn to observe the landing site – a constant radius turn is required to maintain a constant distance.

The pattern

Before the throttle is closed to simulate the engine failure, all the considerations of wind, elevation, landing site and reference points are discussed. The aim is to demonstrate the ideal forced-landing pattern, and later exercises will require the student to adapt this pattern for the conditions under which the power failure is simulated.

The value of the demonstration and patter will be negated if the student is not aware of which landing site is being used and what features define the 1/3, 1000-foot, and 1500-foot references.

The engine failure will be simulated from _____ feet by closing the throttle. The first demonstration, patter and student practice should be conducted at a suitable altitude so as to introduce the exercise gently and allow them time to put the briefing items into practice.

It's recommended that the exercise begin with the initial actions and a demonstration and patter. This should consist of how the aeroplane is being positioned for the 1500-foot area, the use of spacing downwind to make the 1000-foot area, and how to fly the base leg to make the 1/3 aim point. The checks will be covered in the next lesson.

The aeroplane is positioned on the non-traffic side of the chosen landing site, facing into wind, preferably at least 2500 feet AGL to give information-processing time. Closing the throttle is at your discretion so, once all relevant points about the approach have been observed by the student, position the aeroplane appropriately and start the simulation.

Carburettor heat is selected to HOT, the throttle closed, the initial actions carried out, and the plan activated. Except for the regular engine warm, no other checklists are completed.

Throughout the approach, you should draw the student's attention to the relevant features and wind. The 1500-foot area is relatively easy to achieve because it's such a large area, and the 1000-foot area cannot be missed if the spacing is correct. Problems invariably arise in the judgement of the approach to the 1/3 aim point. This is because the student has spent several hours in the normal circuit, and all their experience in judging an approach has been in relation to a threshold or runway end. It's vital, throughout the base leg, that you repeatedly draw the student's attention to the 1/3 aim point and ask if the student is confident of placing the aeroplane's wheels on the ground at that point.

Judgement of whether the 1/3 aim point can be reached or not is facilitated by maintaining a constant airspeed and noting whether the aim point moves up the windscreen, down the windscreen, or remains constant.

At this point, the objective of this exercise has been achieved. The measure of success is whether or not the 1/3 aim point could be easily reached from this position. Regardless of the answer to that question, you tell the student to go around. You, or the student, must assess whether an earlier go-around is advisable due to turbulence, terrain, stock, or nearby habitation.

In following lessons, the aeroplane will be taken below 500 feet and the student will have the opportunity to more accurately assess if the aim point will be reached.

The aeroplane should be repositioned to the ideal forced-landing start position using the same landing site for student practice.

Student practice

The student should be encouraged to say how confident they are about reaching the 1500-foot area and the 1/3 aim point and their allowance for the wind. If not, you may need to prompt the student with questions, especially if you doubt the aeroplane's ability to reach the nominated references.

Do not use terms such as:

- "This approach looks high/low/correct." Emphasise what the student should be looking at to judge the approach: "This approach looks high in relation to the water trough (1/3 aim point)".
- "Delay flap until you're sure of getting in." You could be "sure of getting in" from 3000 feet AGL over the landing site. Emphasise, "Delay flap to about 500 feet AGL and ensure the water trough (1/3 aim point) can be reached". Provide for exceptions, by stating that "If flap is needed then use it".
- "Can you reach the field?" This draws the student's attention away from the 1/3 aim point to look at the overall landing site. Students who go high/overshoot are usually doing this. Students who go low/undershoot are always looking at the threshold. Emphasise the 1/3 aim point, eg, "Can you reach the water trough?".

Where possible, this exercise concludes either with a demonstration forced landing onto the home aerodrome, or the student is encouraged to fly the pattern down to about 500 feet AGL. During the latter exercise, you make all radio calls so that the student can concentrate on the pattern. Maintain situational awareness and beware of other traffic because a simulated forced landing does not give you automatic right of way.

After flight

The handout on this lesson should include a complete set of checks to be learned before the next lesson.

Your student will be ready for solo exercises to the training area soon, and they should be showing progress in that direction. Encourage them to work on any weaker areas before they are sent solo.

Forced landing without power - pattern

Objective

To be able to select an appropriate landing site and carry out the pattern for a forced landing without power.

Considerations

Configuration

- Best L/D ratio, idle power, prop windmilling, ________ kt
- Effect on range

Wind indicators

Work out direction from:

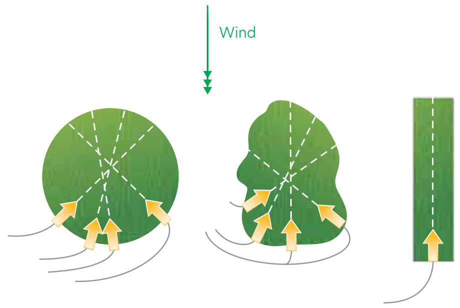
- Smoke
- Dust
- Crop movements
- Tree / leaf movement
- Wind lanes
- Waves and ripples
- Wind shadow
- Cloud shadow
- Drift
- Local knowledge

Landing site

7 Ss, C & E

- Size
- Shape
- Slope
- Surface
- Surround
- Stock
- Sun
- Communication
- Elevation

Consider all shapes of landing sites



Situational awareness

- Always keep an eye out for forced landing options
- Know what the surface wind is, and the better landing areas

Air exercise

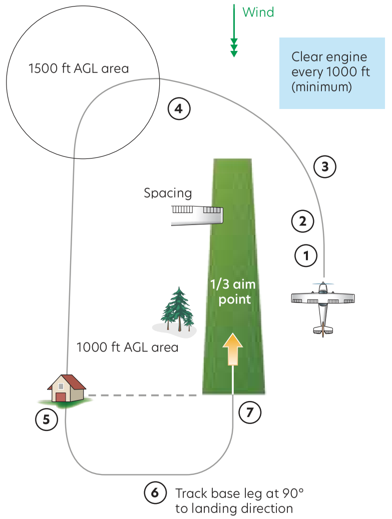
From a cruising altitude...

Immediate actions

- Carb heat HOT, close throttle
- Convert speed to height
- Set glide attitude and trim
- Confirm wind and choose landing site
- Make the plan
- MAYDAY call (if reception is a consideration)

Trouble checks

F	Fuel Selector ON, fuel pump ON, change tanks (touch)
M	Mixture RICH, carb heat HOT, primer LOCKED (Alternate air)
I	Ignition LEFT, RIGHT or BOTH. Ts and Ps
P	Partial power check



Make the plan

① Choose reference points

- Landing aim point – 1/3 way into field
- 1000 ft AGL area – 90° from threshold area, but closer
- 1500 ft AGL area – 500 ft back from 1000 ft AGL area

② Convert heights to altitudes

③ Positioning

- Assess the aeroplane's position and its ability to make it into the 1500 ft area

④ Ask regularly

- "Am I confident of making it to the 1500 ft area"

⑤ After 1500 ft area reached

- Spacing downwind

⑥ Approach starts at 1000 ft area

- Constant assessment of approach by reference to 1/3 aim point
- Can adjust base turn – but not 1000 ft area
- Offset drift
- Ask "Can I reach the 1/3 aim point?"
- Position at 500 ft so can touchdown at 1/3 aim point without flap
- Use flap to bring 1/3 aim point back towards threshold

⑦ Landing phase covered in next lesson

Airmanship

- Checks, including touch checks
- No pax and solo limitations
- "Simulating" to begin with
- Go around – landings later
- Legal limitations

Aeroplane management

- Ts and Ps stable
- Engine warming 1000 ft
- Fly the aeroplane

Human factors

- Don't turn your back on paddock
- Practice will make it easier
- Concentrate on pattern
- Re-evaluate decisions to avoid mindsets

Forced landing without power – considerations

This is the second part of the forced landing without power lesson. It builds on all of the pattern information learned in the previous lesson, and introduces the checklists and further considerations.

In the previous lesson, the student practised the FLWOP pattern and the considerations of how the pattern is planned. They have had the chance in the meantime to start to learn the checks and revise the last lesson. The whole procedure is completed and practised in this lesson.

Aviate and then navigate remain the prime considerations of any emergency. When stress levels are high, always revert to aviate first, navigate second, and use only spare capacity for anything else.

Objectives

To carry out the recommended procedure in the event of a total or partial engine failure, incorporating the appropriate checklists.

To practise aeronautical decision making (ADM) to troubleshoot and rectify a partial power situation.

Considerations

The probable causes of engine failure are revised and the methods of avoiding this are emphasised.

The various factors affecting gliding range are discussed. The effects of L/D ratio, altitude and wind are relevant to the first requirement of landing site selection, ie, the site is within easy reach.

Best L/D

As was seen in the **Climbing and descending** lesson, glide range depends on the best lift to drag ratio.

When the aeroplane glides in the configuration for the best L/D ratio (_____ knots, no flap, propeller windmilling), the angle of attack is about 4 degrees, the shallowest glide angle is achieved, and the range is greatest.

If the nose attitude is lowered to glide at a higher airspeed, the range will be reduced. If the nose attitude is raised to glide at a lower airspeed, the range will be reduced. This can be verified with the VSI.

The visual illusion created by raising the nose – trying to stretch the glide – will require careful explanation.

Although raising the nose can make it look like the aeroplane will reach a more distant field, the aeroplane sinks more steeply than it would if flown at the best L/D ratio. This can also be confirmed with the VSI.

With the aeroplane trimmed to maintain an attitude for the best L/D ratio, if the reference area or point does not move down the windscreen, or at least remain constant – it cannot be reached.

The gliding ability of every aeroplane varies but for the average light training aeroplane, 'within easy reach' is commonly described as: look down at an angle of about 45 degrees and scribe a circle around the aeroplane; anything within the circle is within easy reach.

Height

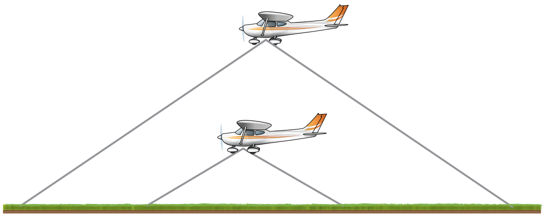
The size of the circle will obviously be affected by height (see Figure 1).

Therefore, another of the most useless things to which a pilot is introduced – sky above you!

Never fly lower than you must!

Figure 1

Altitude affects the choice of possible landing area



Effect of height (altitude)

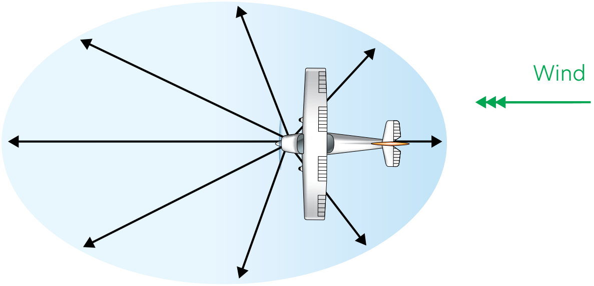
Altitude (height) will also affect the amount of time available for planning and completing the recommended checklists.

Wind

The glide range is increased by a tailwind and reduced by a head wind. Therefore, the affect of wind on range will be to elongate the circle downwind, producing more of an egg shape than a circle (see Figure 2).

Figure 2

The affect of wind on range



Partial power

At the completion of the trouble checks, a check for partial power is made by opening the throttle to full power. If there is no response, the throttle is closed and the forced landing without power continued.

However, if some power is available, for example, 1800 RPM at full throttle, a range of choices become available. These will require the application of aeronautical decision making and pilot judgement.

The first decision to be made is whether to continue with the forced landing by closing the throttle, leaving the engine at idle and not relying on the available power. The alternative is to use the available power to transit to a more suitable landing site. This decision must be made with the knowledge that a partial power failure may become a total power failure at any time.

Even if the decision is made to close the throttle, partial power may be available if required on final approach – but of course, cannot be relied on.

Other factors that will affect the decision are:

- The effect of wind.
- The suitability of the nearest landing site.
- The amount of power available. For example, is there sufficient to fly level at not less than the endurance speed or is a gradual descent required to maintain airspeed?
- The type and height of terrain to be crossed in transiting to a more suitable landing site. For example, will flight over a built-up area be required, or can leapfrogging from landing site to landing site be accomplished?
- The cause of the power reduction (if known). For example, no oil pressure and reduced power can quickly become a total power failure.
- The aeroplane's altitude. Never fly lower than you must.

Airmanship

The engine failure will be simulated from _____ feet by closing the throttle.

Ensure there is sufficient height to complete the checklists without undue haste during early student practice.

Revise the trouble checks, and identify which items are to be touch-checks only.

Introduce the pre-flight passenger briefing. The pre-flight passenger brief is used to describe:

- the type and location of emergency equipment on board,
- the method of getting out of the aeroplane, and
- passenger's actions following a forced landing.

Time spent on the ground reduces the time required to explain these points in the event of an emergency, and it improves the passenger's chances of exiting the aeroplane successfully.

Inform the student that from now on it is their responsibility to initiate the go-around, without prompting from you, at an appropriate height (refer CFI). However, if at any time you instruct them to go around, the student must consider the simulation ended.

The student should be reminded that, when authorised, this exercise may be carried out solo, but some limitations will apply.

In later lessons, this procedure will be carried out onto aerodromes (or landing sites) so that the glide approach can be incorporated and the complete forced landing procedure practised. However, the student should be aware that simulated forced landing practise does not provide them right of way.

Aeroplane management

Stabilise the engine temperature before beginning the exercise.

Warm the engine every 1000 feet, minimum.

Human factors

Do not concentrate on the checklists at the expense of the pattern.

Stress is minimised by knowing the appropriate procedural response to the unexpected, regular practice and thorough pre-flight planning.

Air exercise

Action item checklist

Engine failure will be simulated by partially closing the throttle at 3500 feet AGL for the first lessons, but will vary lower and higher with more practice.

1. Immediate actions:
    a. Select carb heat HOT and close the throttle.
    b. Convert excess speed to height.
    c. Select glide attitude and trim (best gliding speed for type).
    d. Confirm wind direction and select suitable landing area.
    e. Plan the approach and execute.
2. Trouble Checks (FMI):

    F Fuel

    Fuel selector ON, fuel pump ON (if applicable), change tanks (if applicable) (touch).

    M Mixture

    Mixture RICH, carb heat HOT, primer LOCKED.

    I Ignition

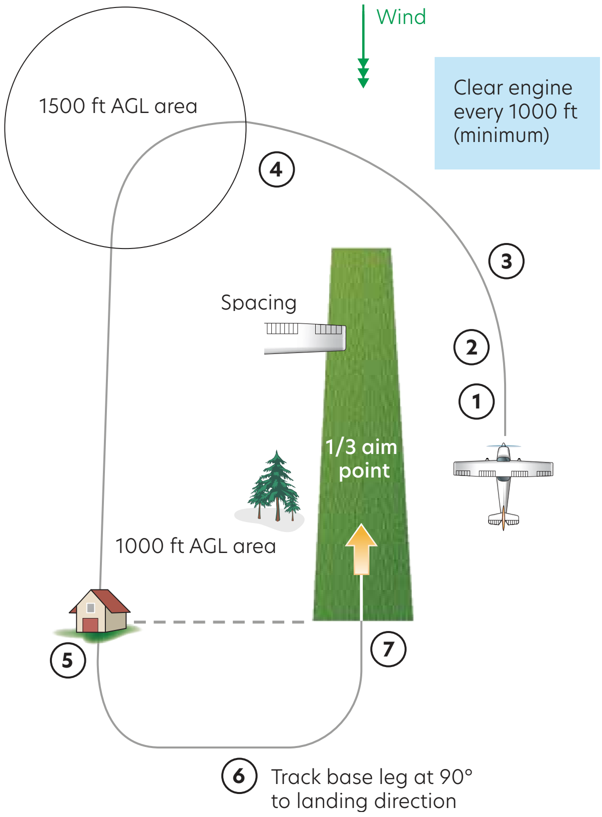
    Ignition on BOTH (touch), check temperatures and pressures.

    P Partial Power

    Power check.
3. Assess the approach, MAYDAY call. Select 7700 and activate ELT. Passenger brief. Engine warm. Assess the approach.
4. Achieve 1500-foot area. Pre-landing checks.
5. Achieve 1000-foot area.
6. Fly the approach.
7. Go-around or landing.

Figure 3

Pattern for a forced landing without power, showing the 1/3 aim point, 1000-foot area, and 1500-foot area



Aviate - Navigate - Communicate

The principles of Aviate - Navigate - Communicate must be followed during FLWOP training.

Aviate	Fly the aeroplane accurately and carry out the checks thoroughly.
Navigate	Maintain situational awareness. Keep the selected landing site in view at all times. Fly the aeroplane pattern so that you achieve this, adjust as necessary.
Communicate	Carry out a simulated MAYDAY call. Communicate with others on board to reassure and assist them.

Immediate actions

Select the carburettor heat HOT and close the throttle fully.

Convert excess speed to height by holding a level attitude until the speed approaches best glide speed, and then select glide attitude and trim. Glide speed of this aeroplane is _____ knots.

Check the aeroplane is maintaining the glide speed, re-trim as necessary. This will need to be checked regularly throughout the pattern.

The importance of good situational awareness comes into prominence here. Knowing the elevation of surrounding terrain and the wind direction (approximately) at all times will help if the engine fails unexpectedly.

With the wind direction confirmed, choose a landing site (with reference to the 'seven Ss, C and E'), and plan the approach. Identify the 1/3 aim point, the 500-foot area, the 1000-foot area, and the 1500-foot area.

The most important part of the plan is assessing progress into the 1500-foot area from wherever the aeroplane happens to be. "Am I confident of reaching the 1500-foot area at _____ feet?" If any doubt exists, a turn toward the area should be immediately started. If no doubt exists, the turn can be delayed.

Through all the above actions, the student should be encouraged to perceive all relevant threats at each stage, and ensure such threats are mitigated in actioning their plan.

Trouble Checks

F Fuel

- Fuel selector ON, fuel pump ON (if applicable), change tanks (touch).
- Fuel pressure and the contents gauges are checked and compared with the fuel tank selected.

M Mixture

- Mixture RICH, carb heat HOT, primer LOCKED.
- These are checked and the mixture, in the case of partial power, altered (touch) to see if there is any improvement in power or smoothness.

I Ignition

- Ignition on LEFT, RIGHT or BOTH (touch), check temperatures and pressures.
- Trying LEFT (touch) and RIGHT (touch) magneto positions for smoother running may keep the engine running. Try to restart the engine with the ignition key (touch) if the propeller is not windmilling.
- Check the temperatures and pressures for any reading outside the green range.

P Partial Power

- Power check.
- Open the throttle to see if any power is available. If no power is available, the throttle must be closed again so as to prevent the engine unexpectedly bursting into life at an awkward moment. In the simulated exercise, the partial power check serves to warm the engine.

Transmit MAYDAY

Assuming the partial power check proved no power is available, make a simulated MAYDAY call. The call can be spoken, but do not press the push-to-talk button!

The mayday transmission must be done reasonably early in the pattern because height is being lost, reducing the effective radio range (line of sight). Normally, this transmission is made on the frequency in use. However, if there is no response, or the frequency in use is considered inappropriate (for example, 119.1 aerodrome traffic), a change to 121.5 (touch) should be made and 7700 (touch) selected on the transponder.

If the Emergency Locator Transmitter (ELT) can be activated remotely from the pilot's seating position, select it ON (touch).

Brief the passengers

Valuable time can be saved here if a thorough briefing of the emergency equipment and exits has been given before flight. You are still responsible, however, for advising passengers of the circumstances and what you need them to do, succinctly and clearly.

If time permits, the chosen landing site and the direction of the nearest habitation should also be pointed out to the passengers.

Exits are unlocked (touch if applicable), but normally left latched. Depending on aeroplane type, exits may be jammed partially open. This prevents the doors from jamming closed should the airframe become deformed. However, it may also weaken the airframe – or it may not be permitted in flight (refer Flight Manual and CFI).

Check for loose objects, harnesses are tight, and all sharp objects such as pens and glasses are removed from pockets.

The passengers are also reminded to adopt the brace position on short final and are given a meeting point. The meeting point is nominated in relation to the aeroplane or some prominent ground feature. It is usually ahead of the aeroplane (upwind), assuming a landing into wind – to minimise the risk of burns should fire break out.

Warm the engine

Warm the engine every 1000 feet of the descent. The last engine warm will be just before the 1000-foot area.

Achieve the 1500-foot area

"Am I confident of reaching the 1500-foot area at feet?" If any doubt exists, a turn toward the area should be immediately started. If no doubt exists, the turn can be delayed.

The downwind leg starts from the 1500-foot area. It is vital that on the downwind leg the spacing is assessed in relation to the nominated point on the airframe to establish the correct circuit spacing.

Prelanding checks (FMI)

These checks take the place of the normal prelanding (downwind) checks.

F Fuel

- Fuel OFF (touch).

M Mixture

- Mixture IDLE CUT-OFF (touch).

I Ignition

- Ignition OFF (touch).
- These checks are carried out to minimise the risk of fire.

M Master

- Master switch OFF (when appropriate).
- In addition, the master switch should be turned off (touch) to isolate electrical current. However, for aeroplanes with electrically operated flap, this action is delayed until the final flap selection has been made.

Achieve the 1000-foot area

At the 1000-foot area, abeam the threshold, start the turn onto base leg while allowing for wind.

Throughout the approach, from the 1000-foot area down to the go-around point, continuous reference is made to the 1/3 aim point. No checks are carried out during this segment.

Approach

Judgement of the approach is helped by repeatedly asking, "Can I reach the 1/3 aim point?".

The aim of this process is to position the aeroplane at about 500 feet AGL, so as to touch down at the 1/3 aim point, preferably without flap.

From a position of about 500 feet AGL, when clearly able to touch down at the 1/3 aim point, the actual touchdown point is brought back toward the threshold by extending flap.

Go-around

At the appropriate height (refer CFI) initiate the go-around. Have the student make an estimate of their ability to land within the available space, and where they think they would have touched down, had the approach continued.

Future lessons can be carried out over aerodromes, where the student will be able to complete the exercise to the ground.

If landing

Discuss pilot actions and responsibilities following an actual forced landing (refer CFI).

For more information on survival after a forced landing refer to the *Survival* GAP booklet.

Airborne sequence

The exercise

Give the student plenty of time to observe the indications of wind direction and strength and to choose a suitable landing site. Revise planning the forced landing pattern before closing the throttle.

Begin the exercise at a suitable height (preferably 500 feet higher than the initial introduction to forced landings) to allow discussion of the checklists during the descent. Although a demonstration and patter may be given the first time the checklists are introduced, it may be of more value to allow the student to fly the pattern and have you do, call or discuss the checks as the plan unfolds (refer CFI).

Once the lesson is complete and during the return to the aerodrome, a partial power failure may be simulated and the considerations discussed.

Once the basic approach pattern has been mastered, the commencement altitude, circuit direction, and choice of suitable landing site should be continually varied so as to expose the student to a wide range of conditions.

After flight

Regular revision of these two exercises (total and partial power failure) will need to be simulated throughout the student's training, as occasional practice will have little real value.

Let the student know that the checks they were given after the last lesson must be committed to memory, as they could be needed at any time.

Forced landing without power - considerations

ADVANCED MANOEUVRES

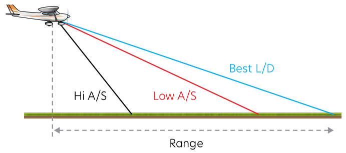
Objectives

- To carry out the recommended procedure in the event of a total or partial engine failure, incorporating the appropriate checklists.
- To practice aeronautical decision making (ADM) to troubleshoot and rectify a partial power situation.

Considerations

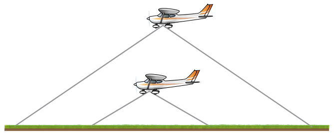
Best L/D ratio - airspeed

- At exactly ________ knots - approx 4° A of A
- Raising or lowering the nose reduces the distance covered
- Never raise the nose to 'stretch' the glide

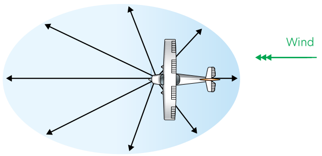


Height

- More height means more distance, and more time to plan


Effect of height (altitude)

Wind



Partial Power

If some power is available:

- Close throttle or go somewhere better?
- What if it fails enroute?
- What is the terrain like enroute?
- What caused the failure? Will it cause more problems?
- How much altitude do you have?

Airmanship

- Simulated by closing throttle
- Trouble checks
- Passenger briefing
- Student to initiate go around
- Landing phase will be practiced later

Aeroplane management

- Ts and Ps stable
- Engine warming every 1000 ft

Human factors

- Pattern more important than perfect checks
- Practice will make it easier

Air exercise

① **Immediate actions**

- Carb heat HOT, close throttle
- Convert speed to height
- Set glide attitude and trim
- Confirm wind and choose landing site
- Make the plan and activate

② **Trouble checks**

F | M | I | P

Assess approach

③ **Mayday call**

- 7700
- Plus ELT activation

Assess approach

Passenger brief

- Nearest habitation
- Remove sharp objects
- Brace position

Assess approach

Engine warm

④ **Achieve 1500 ft area**

- Assess the approach and spacing

Prelanding checks

- Instead of downwind checks
- F-M-I-M (Master after full flap)

⑤ **Achieve 1000 ft area**

- Start base turn

⑥ **Approach**

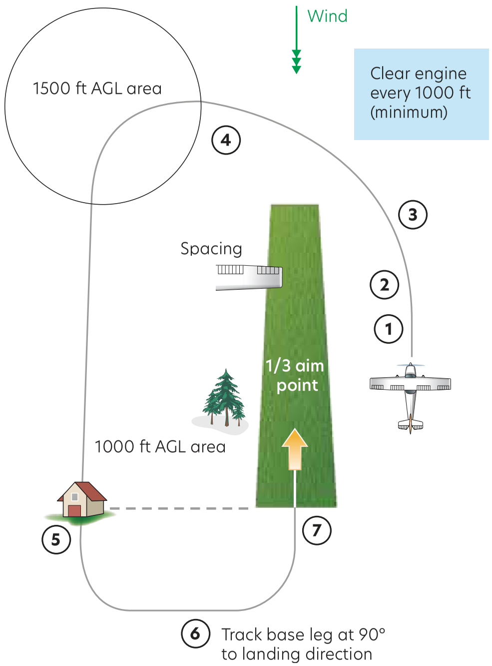
- Can I make the $^1/_3$ aim point?

⑦ **Go-around**

- Would I have made it?

Landing

- PIC responsibility
- Call ATC
- Do not attempt to take off again



Steep turns

For the purposes of the pre-flight briefing, a steep turn is defined as a turn of more than 30 degrees angle of bank. Common practice is to teach the exercise using a 45-degree angle of bank. Good training practice means higher angles of bank, up to 60 degrees, should also be experienced.

The steep gliding turn has been incorporated within this briefing as one method of presenting the material. Some organisations prefer to present a separate briefing on steep gliding turns (refer CFI).

Objectives

To change direction through 360 degrees at a constant rate, using 45 degrees angle of bank, maintaining a constant altitude and in balance.

To become familiar with the sensations of high bank angles and high rates of turn.

To turn at steep angles of bank while gliding.

Principles of flight

Define the steep turn as a level turn at 45 degrees angle of bank.

Explain that the steep turn is taught to increase the student's coordination and skill, but the manoeuvre can also be used to avoid an encounter with cloud, terrain or other aircraft.

In this exercise, the turn is continued for 360 degrees, rolling out on the original reference point, but if you were trying to avoid something you would not turn through a complete circle.

Steep gliding turns will also be covered as applicable to the Forced landing without power lessons, to cover the situation where the base turn needs to be steepened, and to guard against the tendency to pull the nose up as a result of the high descent rate.

Start with a revision the forces in the level medium turn. There should be no need to start with an explanation of the forces in straight and level.

Because we wish to turn at a greater rate we need an increased turning (centripetal) force (CPF). To achieve this, we bank the aeroplane to a steeper angle than in a medium turn, thereby providing a greater acceleration towards the centre of the turn.

However, this inclination of the lift vector decreases the vertical component of lift, therefore increased lift is required in order to provide sufficient vertical component to equal weight. This also further increases the horizontal component, tightening the turn even further.

An example of increasing the bank even further should also be given. An angle of bank of 60 degrees is recommended (refer CFI) because at this point lift must be doubled to maintain altitude (see Figure 1).

To this point the discussion has mostly been revision; now the acceleration forces acting on the aeroplane are described.

The acceleration force opposing CPF is centrifugal force (CFF). This is the acceleration that tries to pull the aeroplane out of the turn. These two forces, CPF and CFF, explain why water in a bucket doesn't fall out when it's swung overhead.

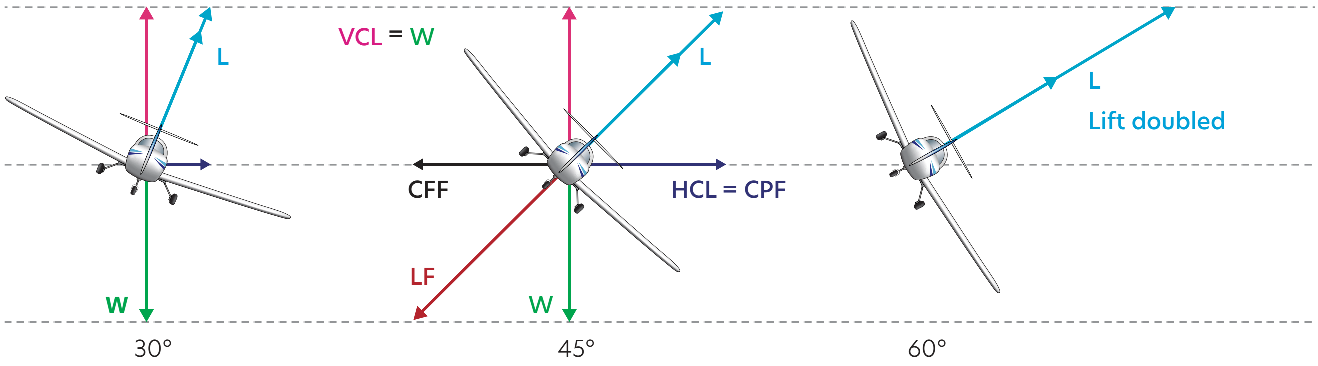
The acceleration pushing the pilot into the seat is known as 'load factor' (commonly referred to as G). This is equal and opposite to lift, and the wings must support it. Therefore, in level flight, where:

$$\frac{L}{W} = \text{LF} \qquad \frac{1}{1} = 1 \text{ or } 1\text{ G}$$

At 45 degrees, the load factor is +1.41G, and at 60 degrees angle of bank the load factor is doubled to +2G, and the student will feel twice as heavy.

Figure 1

Increased lift required to keep the aeroplane level with increased angle of bank



Some organisations mention the effects of banking at 75 degrees (this may be deferred to the **Maximum rate turns** lesson, refer CFI) where the load factor is increased to +3.86 (nearly +4 G). This is usually done only for the purpose of showing that the relationship between angle of bank and G, as well as stall speed, is not linear.

Although your drawing will show all the forces equal and opposite to each other, the aeroplane is not in equilibrium!

Equilibrium is a state of nil acceleration or constant velocity, and velocity is a combination of speed and direction.

Therefore, although the student may have trouble understanding that the aeroplane is accelerating toward the centre of the turn, the aeroplane is clearly not maintaining a constant direction and therefore, by definition, cannot be in equilibrium.

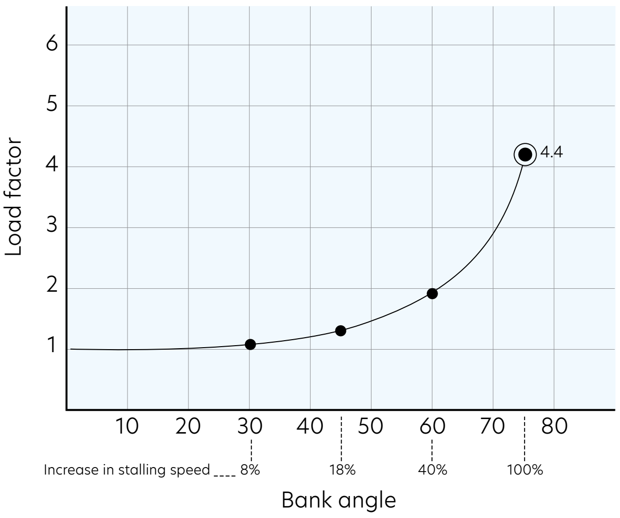
The load factor is often referred to as 'apparent weight' – because it is an acceleration (force) that the wings must support, similar to weight.

The effect of this increase in apparent weight, or load factor, on the stall speed is described.

The stall speed in a manoeuvre (V_{SM}) increases as the square root of the load factor (LF). Assuming a stall speed of 50 knots in level flight, at 60 degrees angle of bank the stall speed will increase by the square root of the load factor +2, which is approximately 1.4. This means that, at 60 degrees angle of bank, the stall speed is increased by 40 percent to 70 knots (see Figure 2).

Figure 2

Increasing load factor, and stalling speed, with increasing angle of bank



- Presentation of the formulas in a preflight briefing is probably not required (refer CFI). However, the numerical effects are normally presented in a table format.

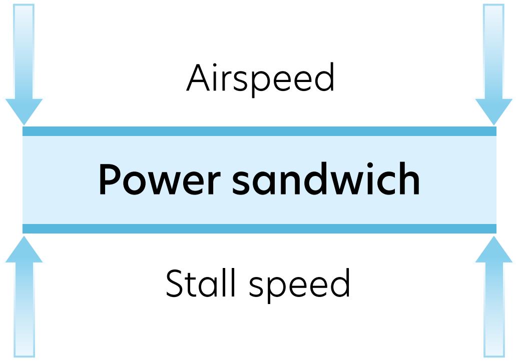
Angle of bank	Load factor	% increase in stall speed	New stall speed
0	1		50
45	1.4	20	60
60	2	40	70
75	4	100	100

At the same time, because lift is increased by increasing the angle of attack, adversely affecting the L/D ratio, the drag also increases – by 100 percent at 45 degrees, and by 300 percent at 60 degrees angle of bank. This increase in drag, or reduction in L/D ratio, results in decreased airspeed.

This is an undesirable situation, with the stall speed increasing and airspeed decreasing. Therefore, the power is increased to combat the increased drag to maintain a margin over the stall speed. This can be referred to as a 'power sandwich' (see Figure 3).

Figure 3

Power is increased to combat increased drag to maintain a margin over the stall speed



In the medium level turn, the lift and drag increase and the adverse affect on the L/D ratio was so slight that the decrease in airspeed was ignored. However, as the increase in drag, load factor, and stall speed is not linear, the effect of increasing drag can no longer be ignored. Therefore, any turn at angles of bank greater than 30 degrees requires an increase in power. At 45 degrees angle of bank this increase will be about 100–200 RPM.

This explanation coincides with the patter of "through 30 degrees increase power" and is the reason why the steep turn is defined as angles of bank greater than 30 degrees.

All of these principles also apply to the steep gliding turn. However, power is obviously not available to oppose the increasing drag and therefore, at angles of bank greater than 30 degrees the airspeed must be increased with any angle of bank increases. At 45 degrees angle of bank, the airspeed is increased by 20 percent of the stall speed (about 5 to 10 knots) to maintain a similar margin over the increased stall speed.

Revise adverse yaw and how it is countered. The amount of rudder required to overcome the adverse yaw is dependent on the rate of roll. The amount of rudder required is kept to a minimum by encouraging smooth control inputs. At low airspeeds, the ailerons will need to be deflected further to achieve the same roll rate of higher airspeeds. This will significantly increase the induced drag and require more rudder to negate the adverse yaw. This will become apparent during gliding turns.

Considerations

Out of balance

If the aeroplane is out of balance in the turn and rudder is applied to centre the ball, the further effects of rudder must be countered.

As rudder is applied, the correct angle of bank must be maintained with aileron. The resulting yaw will pitch the nose above or below the horizon, and therefore an adjustment to attitude will also be required to maintain constant altitude.

The spiral dive

A spiral dive is generally caused by over-banking.

If the angle of bank is permitted to increase, insufficient vertical component of lift will be produced, and the aeroplane will descend. The natural tendency is to attempt to pitch the nose up by increasing backpressure. Because of the high angle of bank, this tightens the turn, increases the rate of descent, and may lead to a stall.

The symptoms of a spiral dive are a high angle of bank, rapidly increasing airspeed and increasing G.

The recovery method is to close the throttle, roll wings level, ease out of the dive and regain reference altitude.

Steep gliding turn

Spiralling down in the modern, low-drag light aeroplane can result in a very rapid increase in airspeed and exceeding the aeroplane's structural G limits.

Airmanship

State any organisation-imposed minimum altitude for the conduct of level steep turns, and the minimum descent altitude for steep gliding turn practice (refer CFI).

Revise **SADIE** checks and the need to counter the effect of wind to remain within the lateral boundaries of the training area.

Revise any VFR requirements considered relevant.

Ensure sick bags are on board.

Aeroplane management

Above 30 degrees, power is increased with angle of bank. A 100-RPM increase at 45 degrees angle of bank is only a guide. Beware of the RPM limit.

Human factors

To minimise disorientation, turns are made through 360 degrees, rolling out on the same reference point as that chosen before starting the turn. Because of the high rate of turn, a prominent reference point should be chosen.

Revise the restrictions imposed by the airframe, and the technique of looking in the opposite direction to the turn, starting at the tail and moving forward through the nose of the aeroplane and into the direction of the turn, so as to minimise possible conflict with aircraft directly behind.

In addition the effects of G on vision can be discussed.

For some students, the sensation of the turn may be uncomfortable at first. The student should be informed that any discomfort will generally be overcome with exposure and practice, but to speak up early if they are uncomfortable.

Air exercise

The air exercise discusses entering, maintaining and exiting the steep level turn at a bank angle of 45 degrees.

Entry

A reference altitude and prominent reference point are chosen and the lookout completed.

The aeroplane is rolled smoothly into the turn with aileron, and balance is maintained by applying rudder in the same direction as aileron to overcome adverse yaw.

Through 30 degrees angle of bank, power is increased with the increasing angle of bank, so that at 45 degrees angle of bank, power has increased by about 100 RPM. At the same time, backpressure is increased on the control column to maintain altitude.

At 45 degrees, which is recognised through attitude and confirmed through instruments, a slight check will be required to overcome inertia in the roll and rudder pressure will need to be reduced to maintain balance.

The indication of 45 degrees bank angle on the artificial horizon should be explained.

Maintaining

Maintaining the turn incorporates the LAI scan. Lookout into the turn is emphasised, and the attitude for 45 degrees angle of bank and level flight is maintained.

The effect of side-by-side seating on attitude recognition should be discussed, preferably with the aid of an attitude window.

During the turn, maintain the altitude with backpressure – provided that the angle of bank is correct. Maintain lookout around airframe obstructions by moving the head.

If altitude is being gained or lost, first check angle of bank. If the angle of bank is correct, adjust backpressure to maintain constant altitude.

Emphasis is placed here on establishing the correct angle of bank to prevent the onset of a spiral dive.

Exit

Look into the turn for traffic and the reference point. As a guide, allow for inertia by anticipating the roll out by about half the bank angle before the reference point. For the average training aeroplane, this will be 20 degrees.

Smoothly roll wings level with aileron, balance with rudder in the same direction to overcome adverse yaw, and relax the backpressure to re-select the level attitude. Through _____ knots reduce power to cruise RPM.

Steep gliding turn

The steep gliding turn may be given either as a separate briefing before steep level turn revision (refer CFI) or demonstrated and practised in this lesson.

Enter a steep gliding turn from straight and level cruise by:

- applying carburettor heat,
- closing the throttle,
- maintaining height until the nominated airspeed is reached, and
- rolling to 45 degrees angle of bank,
- lowering the nose to maintain speed,
- Trim.

In the steep gliding turn, the attitude must be adjusted to maintain the nominated airspeed. The risk of not maintaining the moninated airspeed or bank angle could be a spiral dive.

Airborne sequence

The exercise

The student should be capable of taking you to the training area, while operating as pilot-in-command. This will include making all the radio calls, making the decisions about which route to take, what altitude to climb to, and keeping a good lookout.

Once established in the training area, have the student practise medium level turns.

Emphasise lookout before and during the turn.

Take control and patter the student through the first turn. Then have them practise in that direction, while you correct any mistakes. Then have them try on their own, with no input from you until the end. Then take over and demonstrate in the other direction and follow the same sequence.

During one of the demonstrations, either left or right, ask the student to lift a foot off the floor so as to experience the effect of G.

Discourage any tendency by the student to lean out of the turn.

Once the student has completed satisfactory steep level turns both left and right, the effects of an out-of-balance situation and/or the spiral dive should be demonstrated or practised. Recovery from a spiral dive should be covered (refer CFI).

The majority of the lesson will be the student practising the turn. By the end of the lesson they should be able to tell you what they need to work on in future.

On your return to the aerodrome, it may be a good time to practise a forced landing, or an overhead join.

After flight

The next lesson will either be **Maximum rate turns** or **Wing-drop stalling**. Remind the student that you will be expecting them to practise these exercises solo, and to have shown improvement when you next fly with them.

Steep turns

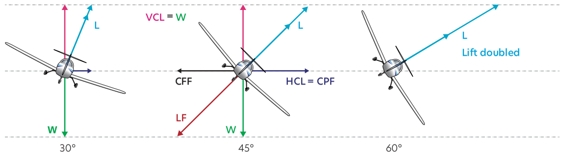
Objectives

- To change direction through 360 degrees at a constant rate, using 45 degrees angle of bank, maintaining a constant altitude and in balance.
- To become familiar with the sensations of high bank angles and high rates of turn.
- To turn at steep angles of bank while gliding.

Principles of flight

- 45° AoB
- Avoidance / coordination – practice 360° turn
- Also cover steep gliding turns

$$\frac{L}{W} = LF \quad \frac{1}{1} = 1 \text{ or } 1\text{ G}$$



Angle of bank	Load factor	% ↑ in stall speed	New stall speed
0	1		50
45	1.4	20	60
60	2	40	70
75	4	100	100

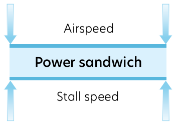
- Increased apparent weight increases stall speed
- Increased drag: 100% at 45° AoB
  300% at 60° AoB
- Reduces airspeed → power sandwich
- Need to increase power

Steep gliding turn

- Cannot increase power, therefore increase airspeed by lowering nose

Adverse yaw

- Amount of rudder required to overcome depends on rate of roll
- Low airspeeds require more aileron deflection therefore more adverse yaw



Air exercise

Entry

- From S+L
- Choose prominent reference point
- Lookout
- Roll with aileron, balance with rudder
- Through 30° AoB increase power and backpressure
- At 45° AoB, check with ailerons, reduce rudder to maintain balance

In turn

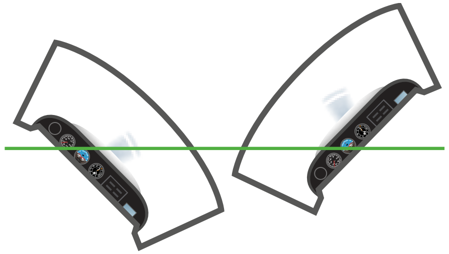
- Lookout
- Attitude
- Instruments
- Angle of bank controlled with aileron
- Altitude controlled with backpressure
- Lookout
- If altitude changing check AoB first, then backpressure

Exit

- Look for reference point
- Anticipate rollout by half the angle of bank (20°)
- Roll wings level
- Balance with rudder
- Relax backpressure
- Reset S+L attitude
- Through ________ kt, reduce power
- Check **PAT**

Steep gliding turn

- Carb heat HOT
- Close throttle
- Maintain height until glide speed reached
- Roll to 45° AoB
- Lower the nose to maintain glide speed
- Trim



Considerations

Out of balance

- When correcting with rudder keep correct AoB and adjust attitude

Spiral dive

- Caused by overbanking
- Aeroplane descends, tendency to ↑ backpressure, → turn tightening and ↑ RoD
- Recover by closing throttle, rolling wings level, ease out of dive

Steep gliding turn

- At PPL level, not recommended, but if have to: idle power, max 45° AoB, attitude to maintain speed

Airmanship

- Minimum altitude
- **SADIE** checks
- VFR minima
- Sick bags

Aeroplane management

- 100 RPM increase

Human factors

- 360° turns
- Lookout restrictions
- Effect of G
- May be uncomfortable

Advanced stalling

This lesson covers the factors that affect the observed airspeed and nose attitude at the stall.

Although the aeroplane always stalls when the aerofoil is presented to the airflow at too high an angle (>15 degrees) most aeroplanes are not fitted with an angle-of-attack indicator. Therefore, it is common practice to use the aeroplane's stalling speed (V_S) as a reference.

In level flight, the airspeed and nose attitude will vary depending on the aeroplane's configuration (speed, power, flap, and gear settings) and therefore airspeed and nose attitude are not reliable indicators unless the configuration for the phase of flight is considered. As was seen in the climbing lesson, the aeroplane has a high nose attitude and a low airspeed but is nowhere near the stall.

The purpose of this exercise is to revise the causes of the stall and to compare the aeroplane's nose attitude and airspeed approaching the stall in various configurations, and then to recover from the stall.

Objectives

To experience the effect of power and flap on the aeroplane's speed and nose attitude at the stall.

To recognise the symptoms of the stall.

To stall the aeroplane and be able to recover from the stall by taking appropriate action.

Principles of flight

The aeroplane's manufacturer provides stalling speeds for one or more configurations as a guide to the pilot. For example, from level flight with a slow deceleration, power at idle, and flap up, when this aeroplane reaches the critical angle, the airspeed will read ____ knots.

Although the critical angle remains constant, the stall speed will vary for other configurations and with several factors.

$L = C_L \frac{1}{2} \rho V^2 S$

L = angle of attack x airspeed

Lift primarily varies with angle of attack and airspeed. Since the critical angle cannot be altered, anything that increases the requirement for lift will require an increase in airspeed to produce that lift. Therefore, when the critical angle is reached, the airspeed will be higher.

↑ L = angle of attack x ↑ airspeed

Anything that decreases the requirement for lift will decrease the airspeed observed at the stall.

The mnemonic 'WILPS' can be used to remind us of the factors affecting the stall; the first three increase the stall speed the last two reduce it.

Weight

An increase in weight will require an increase in lift, resulting in an increase in the stalling speed.

↑ W → ↑ L → ↑ V_S

Ice or damage

If ice forms on the wing, or it's damaged, the smooth airflow over that part of the wing will be disturbed, allowing the airflow to break away earlier. The effect of ice is twofold, in that it also increases the aeroplane's weight.

In flight, generally ice will form on the airframe only if the aeroplane is flown in cloud.

The most common danger from ice in New Zealand is its formation on the wings and tailplane of aeroplanes parked overnight, and sometimes it is so thin and clear that it is hard to detect. No attempt should ever be made to take off with ice or frost on the wings or tailplane, because of its effects on the smooth airflow and the resulting increase in stall speed – which cannot be quantified and may be well above the normal rotate speed.

Loading

Explaining this effect is one reason why advanced stalling is often left until after solo circuits and steep turns; before first solo the explanation is kept as simple as possible.

Loading, or load factor, is the name given to the force/acceleration that the aeroplane must support, for example, in pulling out of a dive. When you ride a roller coaster, at the bottom of the dip you feel heavier, as you're pushed into your seat by the force/acceleration of changing direction. For an aeroplane, this is often referred to as apparent weight, or G, and this increase in apparent weight increases the requirement for lift, and increases the stall speed.

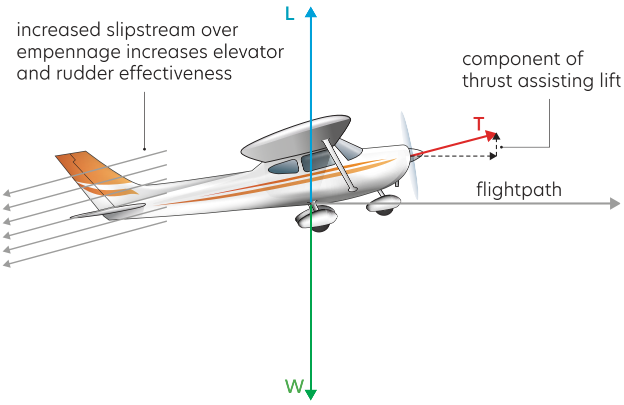
↑ apparent W → ↑ L → ↑ V_S

Power

If the aeroplane could climb vertically there would be no requirement for lift at all. So when thrust is inclined upwards, it decreases the requirement for lift and reduces the stalling speed. In addition, the slipstream generated by having power on increases the speed of the airflow and modifies the angle of attack (generally decreasing it) over the inboard sections of the wing. The increased airspeed increases the lift and reduces the aeroplane's stall speed, and the modified angle of attack increases the nose-high attitude (see Figure 1).

Figure 1

When thrust is inclined upwards, it decreases the requirement for lift and reduces the stalling speed



Slats, slots, or flap

Flap increases lift and therefore the stalling speed is reduced. However, flap also changes the shape of the wing, and this results in a lower nose attitude at the stall.

The effect of flap on the lift/drag ratio should be revised, with particular emphasis on the reason the flap is raised gradually during stall recovery.

Although flap increases lift, it also increases drag – generally, about the first 15 degrees of flap increases lift with little adverse affect on the L/D ratio. It should be appreciated however, that any use of flap will decrease the L/D ratio.

The application of any further flap rapidly increases drag, adversely affecting the L/D ratio.

The point at which drag rapidly increases varies with aeroplane and flap type, but this is usually at the flap setting recommended for a soft-field take-off.

Slats and slots allow the aircraft to operate at a higher C_L (lift coefficient) max, re-energising the boundary layer and therefore stall speed is reduced.

Use of aileron

If, at the stall, the aeroplane starts a slight roll, using aileron to stop the roll (a natural tendency) will increase the angle of attack on the down-going wing. This decreases the lift even further and increases the drag, continuing the roll – not stopping it.

This is the reason for maintaining ailerons neutral in the initial stall recovery and using rudder to keep the aeroplane straight on the reference point.

Airmanship

Reiterate that passengers should not be carried during this exercise.

Situational awareness considers not only the position of the aeroplane three dimensionally within the training area but also the warning symptoms of the approaching stall, and awareness of the flight phase – power reduced but attempting to maintain level flight.

It also includes an awareness of other traffic.

Revise the **HASELL** checklist.

H Height (not altitude)

Height sufficient to recover by not less than 2500 feet above ground level.

A Airframe

The entry configuration is revised: power, flap.

S Security

No loose articles, harnesses secure.

E Engine

Temperatures and pressures normal, mixture rich, fuel sufficient and on fullest tank, fuel pump on.

L Location

Not over a populated area and clear of known traffic areas, including aerodromes.

L Lookout

Carry out a minimum of one 180-degree, or two 90-degree, clearing turns, to ensure other traffic will not result in conflict.

Revise the **HELL** checks.

H Height (not altitude)

Height regained or sufficient to recover by not less than 2500 feet above ground level.

E Engine

Temperatures and pressures normal.

L Location

Not over a populated area and clear of known traffic areas, including aerodromes.

L Lookout

One 90-degree clearing turn.

Aeroplane management

Review the use of carburettor heat.

Revise the need for smooth throttle movements.

Monitor and manage the engine temperatures and pressures between stalls.

Human factors

The regular turns and steeper than normal nose attitudes could lead to some disorientation. Make sure the student has time between stalls to orientate themselves.

This exercise may produce some discomfort in the student, especially if your aeroplane type has a tendency to wing drop. Reassure the student that this is not a dangerous exercise when conducted above 3000 feet – as you will be doing. Tell the student that if they feel uncomfortable at any point, they should say so. The aeroplane can then be flown level until they feel comfortable to continue.

Air exercise

HASELL checks are completed and a prominent outside reference point on which to keep straight is nominated.

Start by carrying out a basic stall entry and recovery as a reference to compare the effect power and flap has on the stall. In particular, the student should identify the attitude, speed and recovery references.

Then teach the effects of power on the stall.

Then the effect of flap on the stall.

Finally teach the effect of power and flap combined on the stall.

Entry

From level flight, carburettor heat is selected HOT and the power smoothly reduced to ____ RPM. As the nose will want to yaw and pitch down, keep straight with rudder and hold the altitude with increasing backpressure.

If selecting flap below ____ knots (within the white arc) select full flap gradually and prevent the tendency for the aeroplane to gain altitude or 'balloon' with the rapid increase in lift, by checking forward or relaxing the backpressure.

Full flap is recommended so that raising the flap can be practised in the recovery sequence.

Through ____ knots, or when the aural stall warning is heard, select carburettor heat to COLD, as full power will shortly be applied.

Stall warning symptoms

Decreasing airspeed and high nose attitude

The first symptom is decreasing airspeed. The rate at which the airspeed decreases will be affected by the amount of power and flap being used, probably faster in this case with full flap.

Note the effect of power on attitude and airspeed at the stall.

Note the effect of flap on attitude and airspeed at the stall.

Low airspeed and a high nose attitude are not always present in the approach to the stall as was demonstrated in the no power, full flap, case. However, for most phases of flight, low airspeed and high nose attitude are valid indicators; so too is quietness.

Less effective controls

The next symptom is less effective control as a result of the lowering airspeed. However, the effectiveness of the rudder and elevator will be determined by the amount of power being used. In this case, the elevator will generally retain sufficient effectiveness to bring the aeroplane to the critical angle without a sink developing. Control pressure in pitch will be heavier.

Stall warning device

The stall warning device (which is not a true symptom) follows this. Because the stall speed with power and/or flap is reduced, the stall warning will sound later, at a lower airspeed.

Buffet

The last symptom is the buffet. The amount of buffet detected depends on the mainplane and tailplane configuration, as discussed in basic stalling. In both the high-wing/low-tailplane and low-wing/low-tailplane types, the flap deflects the airflow down onto the tailplane, and the buffet will be more noticeable. This will depend on the power setting used, as the slipstream may mask any increased effect. In the low-wing/high-tailplane arrangement there may be little change, but again depending on slipstream effects.

Remind the student to observe the attitude and when the aeroplane stalls note sink and the nose pitching down.

Recovery

The recovery is still in two parts, but coordination and speed of execution are increased.

To unstall

Decrease the backpressure, or check forward, with ailerons neutral and remaining straight on the reference point with rudder. The student should be reminded that check forward with the elevator is a smooth but positive control movement but not a push.

The correct use of aileron must be reinforced to produce the required automatic response.

To minimise altitude loss

Full power is smoothly but positively applied – use rudder to keep straight – and the nose is smoothly raised to the horizon. There is no need to hold the nose down as excessive altitude will be lost, while increasing backpressure too rapidly, or jerking, may cause a secondary stall.

The result is sufficient to arrest the sink and minimise the altitude loss.

Hold the aeroplane in the nose-on-the-horizon attitude and reduce the flap setting (as appropriate to aeroplane type) immediately. Do not raise all the flap at this stage, for example in a PA-38 reduce to one notch of flap, or in a C152 reduce the setting by at least 10 degrees. Any benefit of attitude plus power will be reduced the longer the aeroplane is held in the nose-on-the-horizon attitude with full flap extended.

A pitch change will occur as flap is raised if uncorrected, therefore, the nose attitude must be held constant. In addition, flap should not be raised with the nose below the horizon, as this will result in considerable altitude loss.

Before raising the remaining flap, there are three criteria that must be met:

1. safe altitude,
2. safe airspeed (above a minimum and accelerating), and
3. a positive rate of climb (to counter the sink as a result of reducing lift through flap retraction).

When these conditions have been met, raise the remaining flap and counter the pitch change. The aeroplane will continue to accelerate, and at the nominated climb speed, select the climb attitude.

Straight and level flight should be regained at the starting altitude, and the reference point or heading regained if necessary.

Recovery from the stall is paramount. Minimising height loss is only critical if close to the ground, and in that case, a maximum of 100 feet for standard recovery, or 50 feet for onset recovery, is appropriate.

Airborne sequence

On the ground

The student should be able to get the aeroplane ready for flight, and carry out the checklists.

The exercise

The student should now be able to take you to the training area and position the aeroplane within the training area at a suitable altitude, completing the necessary checks, and carrying out the basic stall and recovery. Your assistance is given only as required.

To refamiliarise the student with the stall nose attitude or airspeed, the student should start by carrying out at least two basic stalls, with recovery at stall and then at onset with minimum height loss.

This exercise is leading the student to the realisation that in the approach configuration, the attitude at the stall is noticeably lower than might be expected, and that throughout a normal approach, the aeroplane's nose is well below the horizon. The emphasis is on the observed attitude at the stall more than the indicated airspeed although the lower airspeed should be noted.

Demonstrate a stall with some power and no flap, and recover. Point out the nose-high attitude and lower airspeed. The more power used, the more noticeable the increased nose-high attitude and the lower the stall speed. At high power settings with no flap, the entry can be considerably prolonged (unless altitude is gained). Therefore, normally somewhere between 1500 and 2000 RPM should be sufficient (refer CFI).

Then demonstrate a stall with no power and full flap, and recover. Point out the nose-low attitude, often similar to the straight and level attitude, the lower airspeed, and with flap how quickly airspeed reduces.

During the demonstrations or follow-through of the stall, with power only, and then flap only, you must ensure that a constant altitude is maintained during the entry, as any tendency to gain altitude will affect the nose attitude observed at the stall.

Once the difference in attitude and airspeed at the stall, as a result of the aeroplane's configuration has been observed, introduce the effects of a combination of power and flap on the attitude and airspeed. Use the approach configuration for this.

After the student has experienced the stall symptoms and recovery technique, move on to recovery at onset. Outside the training environment, the student needs to be able to recognise the symptoms of the approaching stall and recover before the aeroplane stalls.

Rather than nominate the stall warning as the 'symptom' at which to recover, ask the student to tell you the symptoms they expect to see and in which order, and then say them as they occur. The stall warning will typically activate at 1.2 V_S which is too far above the stall to effectively demonstrate and note the symptoms clearly. The student needs to recognise the feel of the aeroplane when near the stall.

If the stall warning is not operative, the buffet, if recognisable in the aeroplane used, may be used as the symptom at which recovery is initiated. The only disadvantage of this is that, with power on, the buffet may be very difficult to detect.

During the entry and recovery, you should emphasis eyes outside on attitude and keeping straight using the reference point, for it will be shown in the wing-drop stall that, if the aeroplane is permitted to yaw, one wing will stall before the other. In addition, smoothly raising the nose to the horizon and countering the effects of raising flap should be emphasised.

The student should be able to return you to the aerodrome, and make most of the radio calls required.

After flight

If this lesson is given after solo and circuit consolidation, it is recommended the next lesson be **Wing-drop stalling**.

Otherwise, the next lessons will be in the circuit, where the student will be learning how to fly a circuit and land the aeroplane. They will be drawing on all of the skills they have learned so far. Ask the student to read any notes on the circuit lessons.

Advanced stalling

Objectives

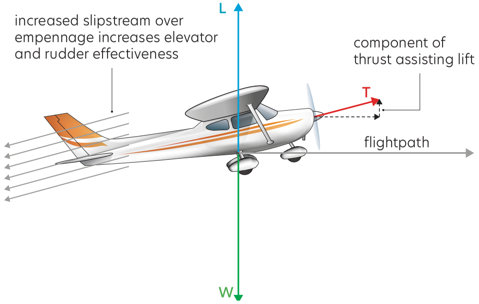
- To experience the effect of power and flap on the aeroplane's speed and nose attitude at the stall.
- To recognise the symptoms of the stall.
- To stall the aeroplane and be able to recover from the stall by taking appropriate action.

Principles of flight

- Aeroplane stalls at critical angle, and speed will vary with configuration
- Manufacturers list stall speeds for simplicity
- L = Angle of attack x airspeed
- Anything that ↑ L required means an ↑ airspeed at the stall
- Therefore airspeed will be higher at the critical angle
- Anything that ↓ L required means a ↓ airspeed at the stall

Factors affecting stall speed

Weight	↑ W requires ↑ L therefore ↑ stalling speed	Same nose attitude
Ice/damage	Changes flow and increases weight, requires ↑ L therefore ↑ stalling speed	Same nose attitude
Loading	↑ Apparent weight requires ↑ L therefore ↑ stalling speed	Same nose attitude
Power	↑ Power requires ↓ L due ↑ airspeed over wing therefore ↓ stalling speed	Higher nose attitude
Slats/slots/flap	Flap ↑ L and ↓ stalling speed	Lower nose attitude
Aileron	Down-going wing will have ↑ AoA, beyond stall ↓ L and ↑ D further → continued roll, not stopping it	



Air exercise

Entry

- HASELL checks and reference point (high)
- Carb heat HOT
- Close throttle/reduce power as applicable
- Keep straight with rudder
- Maintain altitude with ↑ backpressure
- Through ________ kt (white arc) select flap, adjust attitude
- Through ________ kt (stall warning sounds), carb heat COLD

Symptoms

- Observe effects of power, flap, and power and flap
- Low and ↓ airspeed
- High nose attitude
- Less effective controls
- Stall warning – if fitted
- Buffet

At the stall

- Aeroplane sinks and nose pitches down

Recovery

To unstall

- Check forward with control column to reduce angle of attack
- Do not use ailerons

To minimise height loss – max of 100 ft

- **Power + Attitude = Performance**
- Unstall, as above, check forward
- Apply full power – balance with rudder
- Raise nose to the horizon (stops sink and allows acceleration)
- Reduce from full flap, 1 setting
- At safe altitude, safe airspeed, and +ve RoC, raise all flap, adjust attitude
- Regain starting altitude and S+L

Recovery at onset

- Normal situation – when not training
- Recover at stall warning / buffet
- Height loss – 50 ft maximum

Airmanship

- No pax
- Awareness of aircraft configuration, symptoms, traffic
- HASELL checks
- HELL checks

Aeroplane management

- Smooth but positive throttle and control movements
- Carb heat
- Ts & Ps

Human factors

- More practice and exposure the better
- Plenty of time between stalls to orientate
- Unusual attitude possible, but plenty of height for recovery

Maximum rate turns

To achieve the maximum rate of turn, the greatest possible force toward the centre of the turn is required. This is achieved by inclining the lift vector as far as possible. Therefore, maximum C_L (coefficient of lift), achieved at the maximum angle of attack, is combined with the maximum angle of bank.

The maximum rate of turn occurs when the aeroplane is changing direction at the highest possible rate, ie, maximum degrees turned through in minimum time. In most light two-seat training aeroplanes, the angle of bank during this exercise is approximately 60 degrees.

A minimum radius turn achieves a change of direction using less space and is usually done at a lower speed.

This briefing discusses the factors that limit the rate of turn, not only for the aeroplane being flown, but also for fixed-wing aeroplanes in general, so that the principles may be applied to subsequent types.

For the purposes of collision avoidance in response to an emergency situation, the turn entry requires a rapid roll in. The roll out is smoothly executed because the emergency is over. It should be noted, however, that the need to do a maximum rate turn suggests earlier poor decision making.

As an exercise, the rapid-roll in and smooth roll out provide excellent coordination practice, because two different rates of rudder and elevator application are required to match the rate of roll. Logically, these turns would not be continued past 180 degrees in the case of collision avoidance.

Objective

To carry out a balanced, maximum rate, level turn using full power.

Principles of flight

The limitations of turning while using the highest possible angle of attack and at the highest possible angle of bank are discussed.

Briefly revise the forces in the turn and the increasing load factor with increasing angle of bank.

Maximum lift

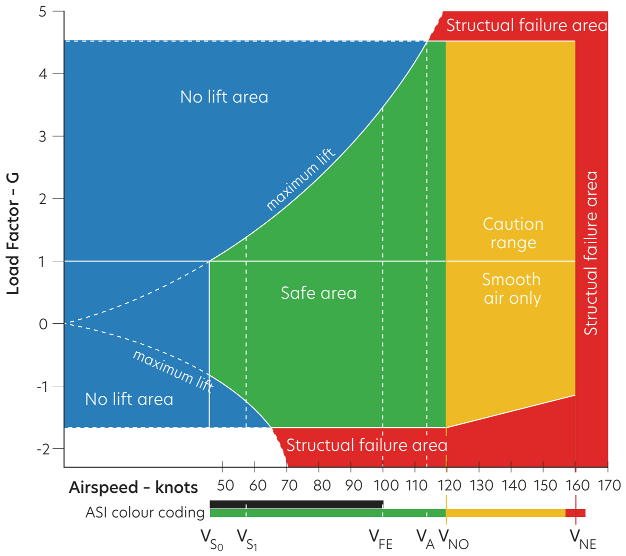
Lift varies with angle of attack and airspeed. The highest useful angle of attack is just before the critical angle, about 15 degrees. At this high angle of attack, maximum C_L, considerable drag is produced, and if the aeroplane stalls, or the buffet is reached, the drag will increase dramatically. Ideally, sufficient backpressure should be applied to activate the stall warning (if it is operating) on its first note. Alternatively, the very edge of the buffet will need to be used as a guide to maximum C_L.

Note: flying the aeroplane with the stall warning activated and not carrying out the stall recovery could be considered negative transfer. On the other hand, considerable situational awareness is required to purposely operate the aeroplane in this regime.

Airspeed

Figure 1

Vg diagram – velocity versus G loads or load factor



Definitions

V_A	Design manoeuvre	V_{S_0}	Stall speed – flaps extended
V_{NO}	Normal operating speed	V_{S_1}	Stall speed – clean
V_{NE}	Never exceed speed	V_{FE}	Maximum speed with flap extended

The speed we are particularly interested in, with regard to maximum rate turns, is V_A (see Figure 1).

V_A is the maximum speed at which the pilot can make abrupt and extreme control movements and not overstress the aeroplane's structures. Above V_A and the aeroplane can be overstressed before it stalls. Below V_A the aeroplane will stall before it is overstressed.

This is a particularly important consideration if the nose is allowed to drop during steep turns, and the pilot pulls back harder on the control column to regain height. The correct recovery technique is to reduce the angle of bank before increasing the back pressure.

V_A is determined by multiplying the basic stall speed by the square root of the maximum load factor. If the aeroplane has a basic stall speed of 50 knots and a maximum flight load factor of 4, the V_A speed would be 100 knots ($50 \times \sqrt{4} = 100$). Practically, the speed will be found in the Flight Manual.

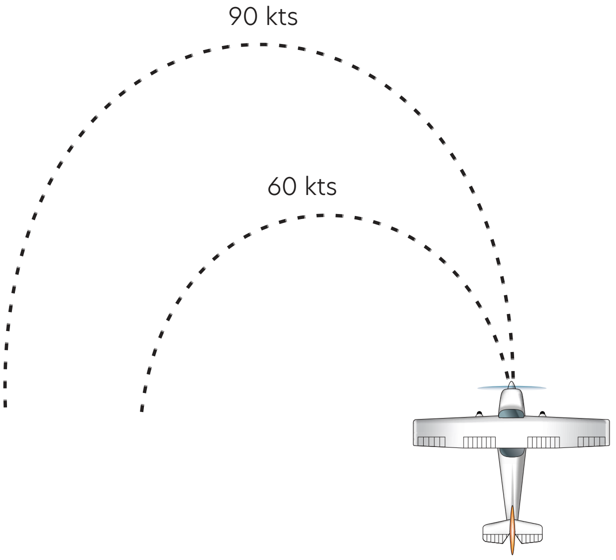
V_A is affected by the aeroplane's weight and reduces as weight reduces. This is because a heavier aeroplane will take longer to respond to a full control deflection than a lighter aeroplane. The quick response of the lighter aeroplane results in higher loading. Therefore, as the weight of the aeroplane is reduced, the speed at which full and abrupt control movements can be made is also reduced (refer Flight Manual).

Rate of turn is the rate of change of direction, ie, how many degrees are turned through in a specific time, usually a minute.

Radius of turn is the size of the arc made by the aeroplane as it turns.

Figure 2

High airspeed means high turn radius



A low speed means a higher rate of turn; a higher forward speed means a lower rate of turn.

A high speed allows you to generate more lift and therefore use an increased angle of bank, but the high airspeed means the radius of the turn (how many nautical miles it takes to make the turn) is high and therefore the rate will be lower (see Figure 2).

To turn at maximum rate we need maximum centripetal force and maximum lift. The increased angle of attack means increased drag, so full power is used. As rate of turn is proportional to velocity, the limiting factor in a maximum rate turn is power.

If speed is below V_A at entry, full power can be used before rolling into the turn. If speed is at V_A, full power can be applied in conjunction with the roll. When speed is above V_A, roll into the turn first and then apply power, so as not to exceed V_A.

To make a maximum rate turn, you need to turn at the highest angle of bank that can be sustained at the lowest possible airspeed – just above V_S – that is why the stall warning is used to indicate maximum rate.

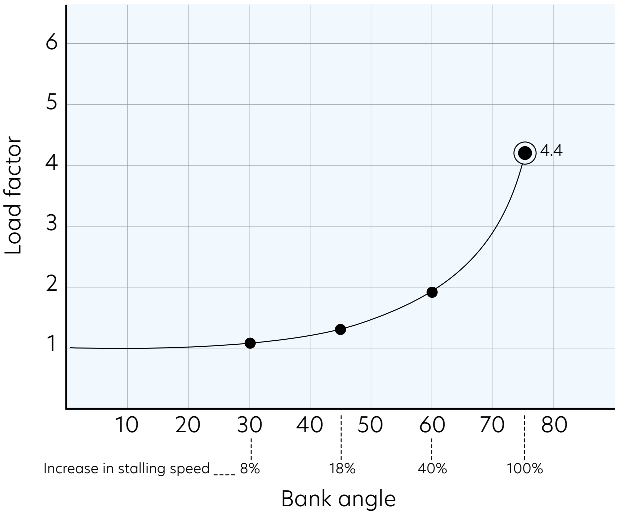
Angle of bank

Somewhere between wings level and 90 degrees there is a practical limit to the angle of bank that can be used, as the aeroplane cannot be turned at 90 degrees angle of bank because there would be no vertical component to balance the weight, no matter how much lift was produced.

Structural limit

Figure 3

Increasing load factor, and stalling speed, with increasing angle of bank



This diagram shows the relationship of load factor to increasing angle of bank (see Figure 3). The structural load limit for the aeroplane will determine the maximum angle of bank that could be used without structural failure. Most light training aeroplanes have positive structural load limits of +3.8G in the normal category and +4.4G in the utility category. It can be seen that this limit is reached between 70 and 75 degrees angle of bank. Therefore, the average light training aeroplane cannot turn at angles of bank greater than about 75 degrees without causing structural damage.

Angle of bank limit

From the graph, state the limiting angle of bank you will be using in your aeroplane.

The steep turn, generally approved as a semi-aerobatic manoeuvre in most light training aeroplane's Flight Manuals, involves an angle of bank of about 60 degrees.

Semi-aerobatic manoeuvres approved in the Flight Manual may be carried out only while operating in the utility category.

The difference between the normal and utility category is determined by the position of the C of G (refer Flight Manual). For most light training aeroplanes there is no difference in the C of G range, only a restriction that the baggage compartment must be empty for the aeroplane to be in the utility or semi-aerobatic category.

As was seen in the **Steep turns** lesson, an increase in angle of bank requires an increase in the angle of attack to increase the lift, which in turn increases drag, adversely affecting the L/D ratio, resulting in a decrease in airspeed.

Power is used to oppose the increase in drag. However, since power available is limited, the airspeed will reduce as the angle of bank increases.

The stalling speed increases as the square root of the load factor. With a basic stall speed of 50 knots, 75 degrees angle of bank increases the stall speed to approximately 100 knots. Even if there were no drag increase this would be about the normal cruise speed.

Therefore, the maximum angle of bank will also be limited by the amount of power available to overcome the increasing drag. For most light training aeroplanes, this is the limiting factor at about 60 degrees angle of bank. With the amount of power available, the highest possible speed that can be maintained is a stall speed well below V_A (about a 40 percent increase over the basic stall speed). However, it's not necessarily the only limiting factor, as a light twin-engine aeroplane or high performance single may well have sufficient power to combat the increased drag and maintain or exceed V_A. Commonly in this case, the aeroplane's structural limitations limit the maximum angle of bank.

Limitations of the pilot

The only other limitation on achieving the maximum rate of turn is that of the pilot.

Considerations

Entry speed above V_A

If the airspeed is above V_A for the weight, the entry must employ a smooth roll in. Generally, the application of power is delayed until the aeroplane decelerates to V_A. Then, power is applied as required to counter the increasing drag in an effort to maintain V_A (for the weight).

Entry speed well below V_A or normal cruise

This would be any airspeed around the stall speed for 60 degrees angle of bank (V_S plus about 40 percent, eg, 50 knots plus 40 percent = 70 knots).

In this case, power should lead the roll-in or be applied rapidly, but smoothly, as soon as the roll-in is started.

Airmanship

The aeroplane's V_A speeds at all up weight and empty (if given in the Flight Manual) are most relevant to this exercise. A stall, or the use of abrupt control movements to initiate the entry, must be avoided above this speed.

Any organisation-imposed minimum altitude for the conduct of maximum rate turns should be stated (refer CFI).

Aeroplane management

For light training aeroplanes, the increase in drag will require that maximum power is used – do not exceed the RPM limit.

The aeroplane's C of G limitations for the normal and utility categories may be revised.

Human factors

Disorientation is minimised by choosing a very prominent reference point. In addition, regular practice at conducting the turn through 360 and 180 degrees (in later lessons, refer CFI) will also improve orientation.

With an increasing positive load factor or G, the heart has more difficulty pumping blood to the brain. Because the eyes are very sensitive to blood flow, the effects on vision of increasing G are noted.

During the maximum rate turn, in most light training aeroplanes, the increased G would not be expected to exceed +2G.

Spots before the eyes form at about +3G, with grey-out occurring at about +4 to +5G, and blackout at about +6G.

These effects vary between individuals and are affected by physical fitness, regular exposure and anti-G manoeuvres or devices, for example, straining, or the use of a G-suit.

Air exercise

The air exercise discusses entering, maintaining and exiting the level maximum rate turn.

Entry

A reference altitude and very prominent reference point are chosen and the lookout completed.

A check is made to establish where the aeroplane's speed is, in relation to V_A for the aeroplane's weight. For most light training aeroplanes the airspeed will be about 10 to 20 knots below VA when entering the maximum rate turn from level flight.

Assuming the airspeed is below V_A, full power is applied and the aeroplane is rolled rapidly, but smoothly, into the turn with aileron, and balance maintained by applying rudder in the same direction as aileron. As large deflections of aileron are used, more rudder than usual will be required to overcome adverse yaw.

Backpressure is increased on the control column to keep the nose attitude level relative to the horizon, pulling smoothly to the stall warning (or light buffet) to maximise lift.

When the stall warning is activated, maintain backpressure and hold the angle of bank to maintain height. This will be recognised through attitude and confirmed through instruments, a slight check will be required to overcome inertia in roll and rudder pressure will need to be reduced to maintain balance.

In the entry from straight and level, excess airspeed may permit a higher angle of bank to be selected initially, especially if the roll is very rapid. However, as the airspeed reduces, the angle of bank will need to be reduced to C_{Lmax} to maintain altitude. Therefore, for the purposes of coordination, it may be beneficial to roll rapidly but smoothly, so that the airspeed reduction coincides with C_{Lmax} and with the application of full power (refer CFI).

If the very rapid roll-in is preferred (for a true avoidance turn rather than a coordination exercise), the initial angle of bank must not exceed the angle of bank at which the structural limits are reached.

Maintaining the turn

Maintaining the turn incorporates the LAI scan. Emphasise lookout, and maintain the attitude for C_{Lmax} and level flight.

The effect of side-by-side seating on attitude recognition should be discussed, preferably with the aid of an attitude window.

During the turn, maintain the maximum amount of lift for the airspeed by maintaining the first note of the stall warning with backpressure.

As the lift cannot be increased any further, the altitude is maintained with angle of bank. Therefore, with the stall warning activated, if altitude is being gained or lost, alter the angle of bank.

Angle of bank can only be increased to the maximum coinciding with the aeroplane's structural limit. An alteration of ±5 degrees angle of bank should be sufficient to maintain altitude.

Exit

Look into the turn for traffic and the reference point, and allow for inertia by anticipating about 30 degrees before (half the angle of bank), and roll out smoothly.

Theoretically, the emergency is over; anticipating by half the bank angle will require a reduced rate of rudder application compared to the entry. This provides practice in coordination.

Smoothly roll wings level with aileron, balance with rudder in the same direction to overcome adverse yaw, and relax the backpressure to re-select the level attitude. Most low-powered training aeroplanes require the reduction of power to be delayed on exiting the maximum rate turn.

Therefore, through ____ knots (normally the same airspeed used in entering straight and level from the climb) reduce power to cruise RPM.

Airborne sequence

The exercise

Once the student has taken you to the training area you should start the exercise with medium level turns, making sure the student notices the attitude. Follow with practice of the steep turns from the last lesson, also noting the attitudes required.

Then you take over and demonstrate, with patter, the maximum rate turn in one direction, followed by student practice with you talking them through, and then the student has the opportunity to practise. Then the other direction.

During one demonstration, the student's attention should be drawn to the rate of turn by looking at the rate at which the nose progresses around the horizon. If the aeroplane is brought to the buffet or stall, the rate of turn will noticeably decrease. Inclusion of this demonstration is at the CFI's discretion.

The majority of the lesson is taken up with student practice, as it may take some time for them to reach an acceptable standard.

After flight

Be clear with the student about whether you are happy for them to practise this exercise solo. There will be plenty of opportunity to practise these in dual flights.

Maximum rate turns

Objective

To carry out a balanced, maximum rate, level turn using full power.

Principles of flight

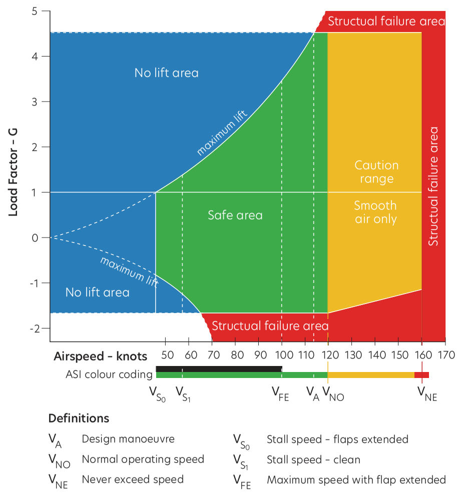
- To change direction at the highest possible rate – maximum degrees in minimum time

Maximum lift

- L ∝ AoA and Airspeed
- Max C_L at start of stall warning or edge of buffet

Airspeed

- Max rate turns limited by V_A
- V_A is the speed at which you can make abrupt and extreme control movements and not overstress the aeroplane's structures
- Found in Flight Manual
- Affected by weight



Rate of turn and radius of turn

- Rate of turn = rate of change of direction – ° /min
- Radius of turn = size of the arc made by the aeroplane
- Slow speed – high rate of turn
- High speed – low rate of turn
- Turning at max rate requires max CPF and max lift
- Rate of turn ∝ velocity therefore power is limiting factor in a max rate turn

Angle of bank

- Between level and 90°

Structural limit

- For this aeroplane is ______ G

Limiting angle of bank

- ↑ in AoB requires ↑ in AoA to ↑ lift, associated ↑ drag → decrease in airspeed
- Power available limited therefore airspeed will reduce as AoB ↑
- Stalling speed ↑ as the √ load factor
- Maximum AoB limited by the amount of power available

Considerations

Entry above V_A

- Smooth roll in, delay power until decelerated to V_A

Entry below V_A

- Lead with power or at same time as roll in

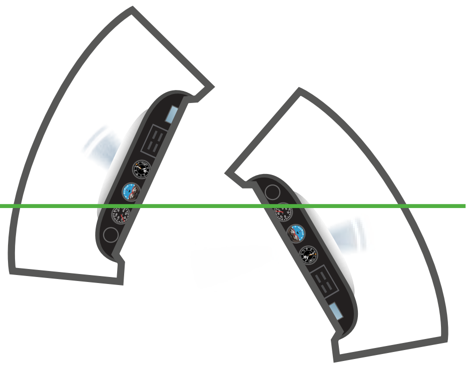
Air exercise

Entry

- Choose reference altitude and prominent reference point
- Check speed relative to V_A
- Apply full power, roll in smoothly, balance with rudder – will need more rudder than usual
- Through 30° AoB increase backpressure to maintain altitude
- Stop at the stall warning (light buffet)
- Check ailerons and rudder
- Maintain backpressure and AoB

Maintaining

- LAI
- Attitude differences due side by side seating
- Maintain first note of stall warning with backpressure
- Altitude maintained with AoB
- With stall warning sounding if altitude is being gained or lost, alter AoB



Exit

- Anticipate roll out by 30°
- Smoothly roll wings level with aileron, balance with rudder, and relax the backpressure to re-select the level attitude
- Delay power reduction
- Through ______ kt, reduce power to cruise RPM

Airmanship

- V_A is ______ kt
- Smooth control movements
- Minimum altitude

Aeroplane management

- RPM limit
- C of G limits

Human factors

- 360° turn to minimise disorientation
- Physical G limits during turn, generally ≤ 2G

Wing-drop stalling

This briefing discusses the reasons why one wing may stall before the other, resulting in the stall commonly known as a wing-drop stall, as well as the consequences and correct recovery technique.

Stalling in the turn may produce the same consequences and requires the same recovery technique. If the turn is to be maintained rather than level flight regained, only the entry and the last item in the recovery are different. Therefore, stalling in the turn may be incorporated in this briefing. However, at the PPL level, the CFI may prefer a separate briefing for stalling in the turn (refer CFI).

By wing-drop stall we mean a stall where one wing stalls before the other. The wing that reaches the critical angle first (at about 15 degrees) will stall first, losing lift and causing a roll at the stall. This often happens because of poor pilot technique where the aeroplane is out of balance at the stall, or aileron is being used.

Once the wing stalls, aileron will not stop the roll, it will worsen the situation. If the wing-drop is not promptly recovered, a spin may develop. The purpose of this exercise is to stop the natural tendency to pick the wing up with aileron and to practise the correct method of recovery.

Objectives

To revise stalling with power and flap.

To carry out a stall from straight and level flight (and the turn) recovering from a wing drop with minimum altitude loss.

Principles of flight

Revise the cause of the stall – exceeding the critical angle of attack, regardless of the observed airspeed.

There are many reasons why aileron may be in use at the stall.

Turning

During the turn, angle of bank is maintained with aileron.

Out of balance

If the aeroplane is permitted to yaw at or near the stall there will be a tendency for the aeroplane to roll (further effect of rudder), which will increase the angle of attack on the down-going wing. In addition, if an attempt is made to maintain wings level with aileron, the down-going aileron will increase the mean angle of attack on that wing. This usually results in that wing reaching the critical angle first.

Ice or damage

If ice forms on the wings, or one wing is damaged, by bird strike or 'hangar rash', the smooth airflow over the wing will be disturbed, and may break away sooner than the flow over the other wing – resulting in that wing stalling earlier than the other.

Weight imbalance

If all the passengers or fuel are on one side of the aeroplane, some aileron will be required to maintain wings level.

Turbulence

When operating near the critical angle, a gust or turbulence may result in aileron being used to maintain wings level, or the modified airflow as a result of the gust may cause one wing to exceed the critical angle.

Rigging

One wing can stall before the other due to incorrect rigging.

Power

Slipstream modifies the angle of attack on each wing because of its rotational nature. In clockwise rotating engines (as viewed by the pilot), the angle of attack is decreased on the starboard wing and increased on the port. Again, due to aileron use, or an increased angle of attack, the aeroplane may drop a wing more readily when partial power is used.

Flaps

It's possible for flap to extend at slightly different angles. In addition, when flap is extended, the aeroplane is less laterally stable, because the centres of pressure on each wing move in toward the wing root. This increases the tendency for the aeroplane to be easily disturbed in roll, which may cause one wing to exceed the critical angle. However, there is also a greater need to use aileron to maintain wings level in this configuration. Therefore, the aeroplane may drop a wing more readily when flap is selected.

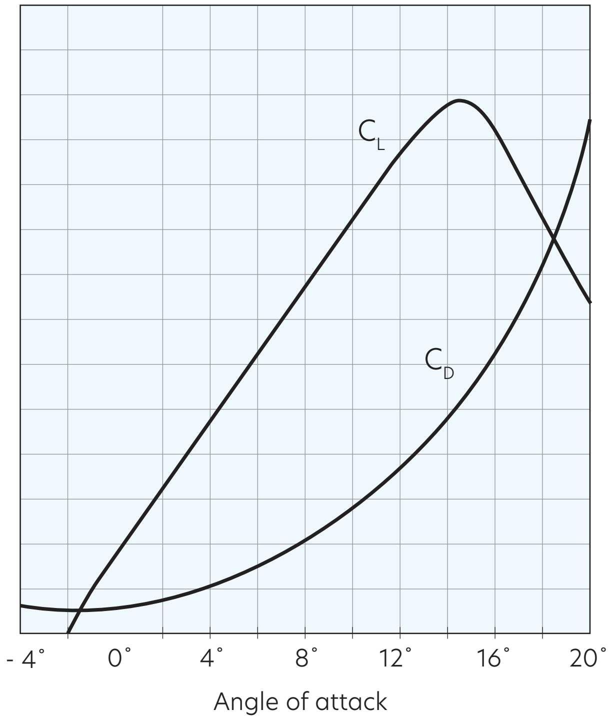
Consequences

The consequences of one wing exceeding the critical angle before the other are discussed.

The wing that stalls first has a reduction in lift, causing roll. The roll increases the angle of attack on the down-going wing and may delay the stall of the up-going wing. Increasing the angle of attack past the critical angle will result in a decrease in lift but a substantial increase in drag – use C_L (coefficient of lift) and C_D (coefficient of drag) against angle of attack graph (see Figure 1).

Figure 1

C_L and C_D versus angle of attack



The increase in drag yaws the aeroplane toward the down-going wing, which may further delay the stall of the up-going wing as a result of increased airspeed. This process, where yaw causes roll, which causes yaw, is known as 'autorotation'.

By using aileron to stop the roll (a natural tendency), the mean angle of attack increases on the down-going wing. The lift continues to decrease with an increase in angle of attack (past the critical angle), while the drag continues to increase rapidly with any small increase in angle of attack. Show the effect of aileron on the C_L and C_D curves on the graph.

The use of aileron adversely affects the roll and favours autorotation. This is the reason for maintaining ailerons neutral in the initial stall recovery.

The correct method of stopping autorotation is to break the yaw-roll-yaw cycle, and since aileron cannot be used effectively to stop the roll, rudder is used to prevent further yaw. The nose is lowered simultaneously by the control column checked centrally forward (no aileron input) with the application of rudder, and this will stop the roll immediately.

Airmanship

Revise the requirement to carry out all stalling practice in a safe environment.

Revise the HASELL and HELL checks.

Emphasise symptom recognition for avoidance.

The student should strive to improve situational awareness by integrating the attitude and airspeed with the aeroplane's configuration, phase of flight, and symptoms of the approaching stall.

Aeroplane management

As the objective is to carry out a stall with a wing-drop, a configuration most likely to induce a wing-drop is used, commonly 1700 RPM and full flap. The combination of these two factors will often lead to a wing-drop occurring at the stall.

Some aeroplane types, eg PA38, will perform good wing-drop stalls in the basic configuration (power idle, flap up) (Refer CFI).

Revise the airspeed and RPM limits.

Human factors

Overlearning is used to improve information processing to recognise the situation and consciously ignore the roll while responding with the correct recovery technique.

Air exercise

Start by revising stalling in various configurations. This will help make the student more comfortable before tackling the wing-drop stalls.

When satisfied that the student is ready to progress, you should begin the exercise with the demonstration and patter of a wing-drop stall (see **Airborne Sequence**).

Entry

HASELL checks are completed, and a prominent outside reference point (backed by the DI) on which to keep straight is nominated.

From level flight, carburettor heat is selected HOT and the power smoothly reduced to ____ RPM. As the nose will want to yaw and pitch down, keep straight with rudder and hold the altitude with increasing backpressure.

Below ____ knots (in the white arc) select flap gradually, if applicable to the aeroplane type. During the application of flap, check forward to prevent any gain in altitude due to the increase in lift, before reapplying backpressure to maintain altitude.

Through ____ knots, or when the aural stall warning is heard, select carburettor heat COLD, as full power will shortly be applied.

At the stall, altitude is lost, the nose pitches down, and one wing may drop.

If the aeroplane is reluctant to drop a wing at the stall, alter the power and flap combination (refer CFI) and relax rudder pressure to simulate the pilot's failure to maintain directional control. Alternatively, a gentle turn may be required (5 degrees angle of bank).

There is nothing underhand about these techniques, as permitting the aeroplane to yaw or stall in the turn are possible causes of a wing-drop stall.

Avoid an accelerated stall (by zooming the entry) which may produce a rapid roll. The student should see a rapid stall at some point in their training, but the first stall is not the time for it. If a pronounced wing-drop occurs, the application of full power may need to be delayed to avoid exceeding flap limiting speeds, or V_{NE}.

Recovery

The recovery may be discussed in three parts, but the ultimate objective is to coordinate all three actions.

To unstall

Keep the ailerons neutral.

At the same time

Simultaneously decrease the back pressure (check forward) and apply sufficient appropriate rudder to prevent further yaw.

Excessive rudder should not be applied (to level the wings through the secondary effect of rudder) as this may cause a stall and flick manoeuvre in the opposite direction to the initial roll (wing drop).

To minimise the altitude loss

Full power is smoothly but positively applied. At the same time, level the wings with aileron (as the aeroplane is now unstalled), centralise the rudder, and raise the nose smoothly to the horizon to arrest the sink and minimise altitude loss.

Hold the nose at the level attitude, and reduce the flap setting (as appropriate to aeroplane type) immediately.

At a safe height, safe airspeed, and with a positive rate of climb, raise remaining flap (counter the pitch change). The aeroplane will continue to accelerate, and at the nominated climb speed select the climb attitude.

Straight and level flight should be regained at the starting altitude and the reference point or heading regained.

Airborne sequence

The exercise

The student should be capable of positioning the aeroplane within the training area at a suitable altitude, completing the necessary checks, and possibly carrying out the advanced stall and recovery. Instructor assistance is given only as required.

For the purposes of demonstration and patter, the recovery may be broken down into three separate phases (refer CFI). Alternatively the three phases may be condensed into two or even one phase, depending on your assessment of the student's ability.

It is recommended that all stalling exercises finish with a reminder that outside of the training environment the student would recover at the onset of the stall at the latest.

At the completion of this exercise, there may be time to practise **Maximum rate turns**, if previously covered.

Wing-drop stalling

Objectives

- To revise stalling with power and flap.
- To carry out a stall from straight and level flight (and the turn) recovering from a wing drop with minimum altitude loss.

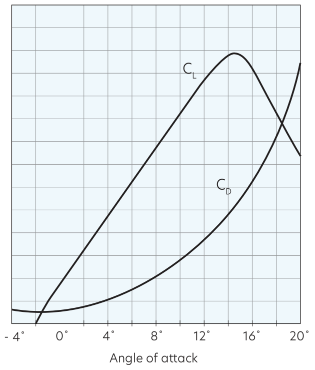
Principles of flight

- Cause of stall – aeroplane exceeding critical angle of attack

Aileron use at stall

Turning	AoB maintained with aileron
Out of balance	• Yaw at or near stall → tendency to roll, which ↑ AoA on down-going wing • Also, if trying to maintain wings level with aileron, down-going aileron will ↑ the mean AoA on that wing
Ice or damage	• Smooth airflow over affected wing disturbed, may break away sooner than over other wing
Weight imbalance	• If all passengers / fuel on one side of the aeroplane, aileron needed to maintain wings level
Turbulence	• May result in aileron being used to maintain wings level, or may cause one wing to exceed the critical angle
Rigging	• Wings fitted at different angles of incidence, or flaps rigged incorrectly – one wing would reach the critical angle before the other
Power	• Slipstream modifies the angle of attack on each wing therefore aeroplane may drop a wing more readily when partial power used
Flaps	• Flap may extend at slightly different angles • Also, with flap extended aeroplane less laterally stable (CoP on each wing moves in toward wing root). ↑ tendency for aeroplane to be disturbed in roll • Also, greater need to use aileron to maintain wings level in this configuration

- Wing that stalls first has a ↓ in lift → roll
- Roll ↑ the AoA on down-going wing and may delay stall of up-going wing
- ↑ AoA past critical angle → ↓ lift but substantial ↑ drag
- ↑ drag yaws aeroplane toward the down-going wing, may further delay stall of up-going wing as result of ↑ airspeed – yaw causes roll, which causes yaw = autorotation
- Using aileron to stop roll → ↑ AoA on down-going wing
  Lift ↓ with ↑ AoA (past the critical angle), while drag ↑ rapidly with any small ↑ AoA
- Rudder used to prevent yaw and lower nose



CL and CD versus angle of attack

Air exercise

Entry

- **HASELL** checks
- Prominent reference point
- Carb heat HOT
- Set power to ________ RPM
- Keep straight with rudder, and maintain altitude with backpressure
- Below ________ kt (white arc), select flap
- Through ________ kt (stall warning) – carb heat COLD
- At the stall, altitude is lost, nose pitches down, and one wing may drop

Recovery

To unstall	Keep ailerons neutral
At the same time	Simultaneously • decrease the back pressure/check forward and • apply sufficient appropriate rudder to prevent further yaw
To minimise the altitude loss	Smoothly but positively apply full power. At the same time: • level the wings with aileron, • centralise the rudder, and • raise nose smoothly to horizon – to arrest the sink and minimise altitude loss

- Hold nose at level attitude, reduce flap setting immediately
- At safe height, safe airspeed and positive RoC – raise remaining flap (counter the pitch change)
- Regain starting altitude and reference point

Airmanship

- **HASELL** and **HELL** checks
- Stall with power and flap
- SA – attitude, airspeed, configuration, flight phase, symptoms

Aeroplane management

- Carb heat
- Airspeed and RPM limits

Human factors

- Overlearn correct technique

Short field take-off and landing

Developing the student's decision-making processes in relation to taking off or landing on runways of minimal length provides a real challenge for the professional flight instructor.

This briefing uses the performance data provided in the Flight Manual to operate the aeroplane at its safe and legal limit.

A short (or minimal) field is one where the runway length is shorter than that normally available for the conditions, but is still sufficient for take-off and/or landing. It's not one that is too short. Nor is it one where the runway length is unknown.

When a runway group number is not available, or is available but less than the aeroplane's group number, reference must be made to the Flight Manual to ensure there is adequate runway length available under the existing conditions. As a rule, if doubt exists under any circumstances, refer to the Flight Manual.

Performance ('P') charts, where available, are a valuable source of take-off performance information. Manufacturer's graphs in Flight Manuals should be used in the absence of P charts. If using the latter, it's recommended that pilots apply the appropriate surface correction factors from Advisory Circular 91-3 *Aeroplane performance under Part 91*.

An approach to a field where the runway length is unknown, or is known to be too short, may occur during the precautionary landing. This is an emergency procedure, but the approach technique is the same as for a short field landing.

The *Take-off and landing performance* GAP booklet is a useful reference for this lesson.

Objectives

To ensure, by calculation, that there is adequate runway length for take-off and landing in accordance with the aeroplane's performance data.

To apply sound decision making principles before adopting the recommended procedure for take-off or approach for a runway of minimal length.

To operate the aeroplane in accordance with the manufacturer's recommended short field techniques in order to obtain the best possible performance.

Take-off considerations

Temperature

The most important effect of temperature is to change density. An increase in temperature will result in a decrease in density. Since the expected engine performance is based on a standard temperature of 15 degrees Celsius at sea level, a correction will need to be made for the actual or ambient temperature.

If you're in the aeroplane, on the field of take-off, the aeroplane's outside air temperature (OAT) gauge gives ambient temperature. Otherwise, this information is provided in a METAR, if available.

Density

Density also affects the indicated airspeed (IAS). As density decreases, IAS decreases. Therefore, as the density decreases, the aeroplane's actual speed (TAS) will need to be increased to achieve the same IAS for any given rotate IAS. This will increase the length of the take-off roll, but the effects of density on engine performance are far more critical.

Pressure altitude

The calculation of pressure altitude (PA) is vital for take-off, as this corrects the aerodrome elevation under the existing conditions to an elevation within the standard atmosphere, and the standard atmosphere is what the expected engine performance is based on.

If you're on the aerodrome of take-off and in the aeroplane, you can simply set 1013 hPa on the altimeter sub-scale and read off the pressure altitude. However, if you're not on the aerodrome of take-off, you need to know the aerodrome's QNH (from the METAR) and elevation (from the aerodrome chart) in order to calculate pressure altitude.

Aeroplane weight

The aeroplane's weight is derived from the weight and balance calculations and will directly affect the take-off and climb performance.

Runway surface

The take-off roll is reduced on a firm or sealed surface compared to a soft or grass surface, as there is less surface friction. Since the take-off performance figures provided in the Flight Manual must be calculated using known parameters, a grass surface is defined as short dry grass. Long or wet grass will markedly increase the take-off distance.

Slope

An up slope increases the take-off distance and a down slope reduces it. The slope of a runway, as a percentage, is given in the operational data on the aerodrome chart in the *AIP* Vol 4.

Headwind component

When the wind is at an angle to the runway in use, the headwind component will need to be calculated. Use the chart provided in the Flight Manual.

Wind

If strong or gusty winds are present, there is always the possibility of windshear in the climbout. If a decrease in wind speed is suddenly encountered during take-off, additional power will not be available to arrest the sink. Therefore, the rotate speed (V_R) and the take-off safety speed (V_{TOSS}) are increased by an appropriate amount to counter the possible effects of windshear.

For steady wind speeds of 10 knots or less, use the book figures.

For winds above 10 knots, this speed is progressively increased (refer CFI and Flight Manual).

Whenever the rotate, take-off safety speed or best angle-of-climb speed needs to be increased because of the conditions, think about whether to continue with the exercise.

Calculation

The calculation of the required take-off or landing distance should be a relatively simple process that encourages its regular use and the application of ADM principles.

The use of performance graphs should have been covered in previous lessons.

Collect all the necessary information and consult the Flight Manual to determine the required take-off distance.

The take-off performance graphs in most light aircraft Flight Manuals provide only one weight, all up weight (AUW). This is because the range of weights for take-off or landing is insignificant and, since AUW cannot be exceeded, provides a safety margin at lower weights. Larger aircraft Flight Manuals provide two or more weights. Where only an AUW is given, lesser weights cannot be extrapolated. AUW must be used regardless of the aeroplane's actual weight.

Using either P charts where available, or the Flight Manual performance data, plus AC91-3 surface correction factors, calculate the distance for take-off under the existing conditions. Compare this with the distance available, as given in the aerodrome chart's operational data, or as determined by other means.

If the take-off distance available is less than the take-off distance required – walk away!

If the take-off distance available is equal to or slightly more than the take-off distance required – think carefully!

Double-check your calculations. Have all factors been properly taken into account?

Remember that an accurately performed short field take-off will be required in order to ensure that the performance data contained in the Flight Manual is met.

Take-off performance figures are based on shiny new engines and propellers – how does this aeroplane compare? Is the surface short dry grass or a bit long? How important is it that a take-off be conducted now – under these conditions – and how will the conditions be affected by a delay?

The calculated take-off distance to a height of 50 feet assumes full power is applied before brake release and that the stated flap setting is used. The distance required for take-off includes the ground roll and the distance travelled over the ground to reach a height of 50 feet at the take-off safety speed (V_{TOSS}) which is based on the aeroplane's stall speed and therefore varies with the weight.

The take-off safety speed (V_{TOSS}) is the speed to be achieved after lift off and before a climb above 50 feet. Although, for most light training aeroplanes, it's commonly the same speed as the best angle of climb speed (V_X). However, this speed does not usually include the use of flap (refer to Flight Manual for manufacturer's recommended procedures and/or CFI).

Some Flight Manuals have two take-off charts, one without flap and another with flap. The use of flap is often recommended for take-off from a soft field or where obstacles are present in the climb-out path (refer Flight Manual). This is because the increase in lift provided by flap allows the aeroplane to lift off sooner at a lower airspeed, thereby minimising the ground roll and surface friction.

Commonly, a lower take-off safety speed (V_{TOSS}) is nominated when flap is used. This is because flap lowers the stalling speed, making a lower take-off speed possible. In addition, the decreased groundspeed resulting from the lower climb airspeed allows a similar angle to the best angle, to be achieved.

Take-off distance calculations should be based on the appropriate performance figures, depending on whether flap is recommended for take-off or not.

Unless all of these are complied with, calculation of the required take-off distance is negated.

As this exercise is not generally carried out from minimal length fields, remember to advise students that such conditions are being simulated.

Do not allow the student to round off the rotate or take-off safety speed to the nearest mark on the airspeed indicator. For example, take-off safety speed 54 knots, which is "near enough to 55 knots". This exercise requires accurate flying skills, and these only come from practice. Although one knot may make no appreciable difference to the aeroplane's performance, this practice will ultimately make a considerable difference to the student's attitude towards performance.

Landing considerations

Aerodrome elevation or pressure altitude

Because of the low power setting used on the approach, aerodrome elevation is used when calculating landing distance and the effects of pressure altitude ignored. However, an increase in altitude will result in a decrease in the air density. As density decreases, IAS decreases and the aeroplane's actual speed (TAS) will be increased for any given indicated threshold crossing speed. Therefore, the aerodrome height above sea level will affect the length of the landing roll, and pressure altitude may be used for more accurate calculations (refer Flight Manual and CFI).

Weight

The aeroplane's weight affects inertia and therefore the stopping distance.

Runway surface

The landing roll is reduced on a firm dry surface compared with a grass or wet surface because of the improved braking action. Remember that grass is defined as short dry grass.

Slope

An up slope decreases the landing distance, and a down slope increases it. Slope is given in the aerodrome operational data.

Headwind component

When the wind is at an angle to the runway in use, the headwind component will need to be calculated. Use the chart provided in the Flight Manual.

Wind

If strong or gusty winds are present, there is always the possibility of windshear on the approach. The approach and target threshold speeds (V_{TT}) are increased by an appropriate amount to counter the possible effects of windshear.

For steady wind speeds of 10 knots or less, use the book figures.

For winds above 10 knots, this speed is progressively increased (refer CFI and Flight Manual).

Whenever the approach or threshold speed needs to be modified, consider whether to continue with the exercise. The answer may be affected by the excess runway available over that required.

Calculating the landing distance

With the necessary information collected, the Flight Manual is consulted in order to determine the landing distance required.

The calculated distance for landing under the existing conditions is compared to that available, which is given in the aerodrome chart's operational data.

If the landing distance available is less than the landing distance required – walk or fly away!

If the landing distance available is equal to or slightly more than the landing distance required – think carefully!

Double-check your calculations. Have all factors been properly taken into account?

Remember that an accurately performed short field landing will be required in order to ensure that the performance data contained in the Flight Manual is met.

The Flight Manual for each aeroplane type states the maximum speed for crossing the threshold, and the flap setting to be used.

The required landing distance in the Flight Manual is calculated from a height of 50 feet above the threshold in the stated configuration. That is, the distance required for landing includes the distance to touch down from 50 feet over the threshold and the ground roll to a full stop.

Crossing the threshold higher than 50 feet, using less than full flap, or crossing the threshold at a higher airspeed, will increase the landing distance.

Airmanship

Pilots should consider their own ability before attempting a take-off from or landing onto a runway of minimum length.

The decision-making considerations of a normal take-off apply; but additional decision making is required in relation to a strong or gusty wind and EFATO.

The possibility of EFATO during a short field take-off requires an amendment to the take-off safety brief. Rather than simply lower the nose, as a result of the very high nose attitude and the low airspeed during the initial climb out, the brief is modified to emphasise immediately and positively lowering the nose.

Discuss the decision making required when deciding to go or to abort the take-off or landing.

Aeroplane management

Full power before brake release is confirmed by checking that the required static RPM is being achieved. This figure (often stated as a range, eg, 2280 to 2380 RPM) is in the Flight Manual.

If static RPM is not achieved, simple ADM should result in a logical sequence of: full power is not achieved therefore, maximum performance cannot be achieved, and therefore, the take-off must not be attempted.

Have an aircraft engineer check out and clear the problem before further flight.

There are a few reasons why static RPM may not be achieved, and consideration of these requires the application of a higher level of ADM.

Icing

Check for carburettor ice and that the carburettor heat control is set to COLD. If this cures the problem, continue with the take-off.

Instrument error

Is this RPM normal for this aeroplane? Has this RPM reading been confirmed by the engineers as indicative of full power in this aeroplane? (If so, why is this state of affairs acceptable? Refer CFI).

Propeller

Is the propeller in good condition, and is it the same propeller installed by the manufacturer on which the static RPM is based. Or has it been replaced with a propeller of coarser pitch?

These last two possibilities cannot be confirmed while sitting at the holding point; taxi back to the start-up area and consult an aircraft engineer.

Human factors

Vision may be affected by the high nose attitude on take-off and terrain ahead may produce a false horizon. Therefore, regular cross-reference to instruments is emphasised.

During an approach to land, perception may be influenced by the visual cues of surrounding terrain, a false horizon or runway length and width. Therefore, regular cross-reference to instruments is emphasised.

Air exercise

Take-off

While holding the aeroplane on the brakes (nosewheel straight) with elevator neutral, full power is applied. Static RPM and temperatures and pressures are checked for normal indications.

Good aviation practice dictates that all take-offs must be made using full runway length.

Ensure a clean brake release, and as soon as the aeroplane starts to move, take the weight off the nosewheel with elevator, to reduce surface friction, and check for normal acceleration.

The nosewheel should be held on the ground until the rotate speed (V_R) is achieved. This will require an adjustment to backpressure as the airspeed increases and the elevator becomes more effective. Rotating early only increases the aerodynamic drag and prolongs the take-off roll.

As V_R is reached, smoothly rotate the aeroplane and lift off (don't 'haul' it into the air). Lower the nose and allow the aeroplane to accelerate to the take-off safety speed (V_{TOSS}). This generally requires only a small decrease in backpressure rather than a noticeable check forward.

On reaching V_{TOSS} the attitude is adjusted and held. As a result of the high power setting and low airspeed, more rudder than normal will be required to keep straight on the reference point.

At a safe height (assuming that any obstacles have been cleared), accelerate to best rate of climb (V_Y) or the normal recommended climb speed (refer CFI). Check the aeroplane is in balance.

Before raising flap (if used), there are three criteria that must always be met: safe height, safe airspeed, and a positive rate of climb. When these conditions have been met, raise flap and counter the pitch change. Allow acceleration to continue, and on reaching the climb speed required (best rate or normal), trim to maintain the appropriate attitude.

Landing

During the downwind leg, the conditions used for the approach and threshold speeds are confirmed and an aim point chosen. The aim point should be as close to the threshold as is safe (consider obstacles on approach). If the exercise is being flown onto a marked runway, a point just short of the numbers painted on the surface is a good choice as an aim point.

The selection of this aiming point should not be confused with the club competition of spot landings, where the objective is to land on a spot, usually well into the runway. Although the same approach technique is employed, nominating an aiming point well into a field of minimal length would negate the landing distance calculations.

The procedure to achieve the optimum aeroplane performance for landing as stated in the Flight Manual is used. The stated performance figures are based on the aeroplane being operated at its optimum.

The turn onto base is carried out in the normal manner but delayed slightly by extending the downwind leg to ensure some power must be used throughout the entire approach.

Because this type of approach employs a low threshold speed, a heavy aeroplane with considerable inertia may not have sufficient elevator effectiveness to initiate the flare even though full elevator deflection may be used. Using power throughout the approach gives total control over the rate of descent and additional elevator effectiveness during the flare.

The approach path is monitored by reference to the aiming point and the power adjusted as required to maintain a steady rate of descent to touch down – power controls the rate of descent. If the aeroplane is correctly trimmed, the power adjustments will be very small.

Once established on final, full flap is selected and the airspeed progressively decreased, by adjusting the attitude, to achieve the nominated target threshold speed (V_{TT}) by about 200 feet AGL. Power will generally need to be adjusted as speed is decreased.

It's important to carry some power into the flare.

If the aeroplane is not properly configured by 200 feet AGL on final approach – that is, on centreline, on correct glideslope, aim point identified, and airspeed correct – go around!

The landing is carried out in one phase. The round-out and the hold-off are combined into the flare (a reduction in rate of descent to zero). The aim is to reduce the rate of sink to zero at the same time as the main wheels touch the ground and the throttle is closed.

The nosewheel is lowered, then brakes immediately applied as required; elevator backpressure is used to keep the weight off the nosewheel. Do not use excessive braking.

Flap is raised on completion of the landing roll.

Airborne sequence

On the ground

The distance required for take-off has been determined as adequate, and flap has been selected in accordance with the Flight Manual.

The exercise

Before line up

The conditions are assessed and compared with the conditions that were used in calculating the required take-off distance.

A decision is made on the rotate and take-off safety speed for the existing conditions.

A safe height at which to accelerate to best rate or the normal climb speed, is nominated dependent on the height of obstacles in the climb out path. An obstacle clearance altitude (OCA) is stated, rather than a height above ground, as an altitude is what the student will see on the altimeter.

The OCA should be varied during subsequent exercises to simulate clearing various obstacles in the climb out path.

The pre-take-off safety brief is completed, with emphasis on a positive check forward, in the event of an EFATO.

On line up

Full runway length is used, and the high reference point is chosen.

If propeller damage is a possibility because of a loose surface, the aeroplane is not held on the brakes. The minimum static RPM is confirmed as soon as full power is applied. At the point of brakes release, always check that the student drops their heels to the floor.

Landing

Except for extending downwind a little to ensure power is used throughout the entire approach, the turn onto base, base leg and the turn onto final are all normal.

On final (it may look like the profile is too low, due to the downwind extension) full flap is selected.

The airspeed is progressively reduced to the nominated target threshold speed by 200 feet AGL.

To reduce the airspeed, the nose attitude will need to be raised, and this usually results in the student assessing the approach as high, with a consequent immediate reduction in power.

During a normal approach, the aeroplane is flown down the approach path at 70 knots, whereas during this exercise the aeroplane sinks down the same or steeper approach path at progressively decreasing speeds. Only the attitude and airspeed are different. The approach profile should never be flat and low.

The importance of selecting an attitude for the required speed, particularly the V_{TT}, and trimming the aeroplane to maintain that attitude, cannot be over-emphasised.

If the aeroplane is not properly configured by 200 feet AGL, or the landing is not assured for any reason – the student should be taught to go around.

Do not allow the student to round off the approach or target threshold speeds to the nearest mark on the airspeed indicator.

A full stop landing should always be made when flying this exercise.

After flight

The student will have plenty of time to practise these take-offs and landings in their circuit flights.

Short-field take-off and landing

Objectives

- To ensure by calculation that there is adequate runway length for take-off and landing in accordance with the aeroplane's performance data.
- To apply sound decision making principles before adopting the recommended procedure for take-off or approach for a runway of minimal length.
- To operate the aeroplane in accordance with the manufacturer's recommended short-field techniques in order to obtain the best possible performance.

Take-off considerations

Temperature	• Changes density. ↑ temperature → ↓ in density. Correction needed • OAT gauge or METAR
Density	• As density ↓ , IAS ↓ therefore as the density ↓ , TAS will need to be ↑ to achieve same IAS for any given rotate IAS • ↑ take-off roll, but effects of density on engine performance far more critical
Pressure altitude	• Corrects airfield elevation under the existing conditions, to an elevation within the *standard atmosphere* • Set 1013 hPa on sub-scale and read off the pressure altitude • Or QNH and elevation required for calculation
Aeroplane weight	• Directly affects take-off and climb performance
Runway surface	• Take-off roll is reduced on a firm or sealed surface compared to a soft or grass surface • Grass surface is defined as short dry grass
Slope	• Up-slope ↑ the TODR • Down-slope ↓ TODR
HWC	• When the wind is at angle to runway, need to calculate headwind component
Wind	• With strong or gusty winds, always possibility of windshear in the climb-out • V_R and V_{TOSS} increased to counter the possible effects of windshear

Calculation

- Information from Flight Manual and AC-91-3
- Take-off performance figures based on new engines and propellers – how does this aeroplane compare?
- Is the surface short dry grass or a long and wet?
- How important is it that a take-off be conducted now – under these conditions – and how will the conditions be affected by a delay?
- Calculated take-off distance to 50 ft assumes full power is applied before brake release and that stated flap setting is used
- TODR includes ground roll and distance travelled over the ground to reach 50 ft at V_{TOSS}
- No rounding of take-off speeds – fly them accurately

Landing considerations

Elevation or PA	• Aerodrome elevation is used when calculating landing distance and effects of pressure altitude ignored • Aerodrome height AMSL will affect LDR and PA may be used for more accurate calculations
Weight	• Affects inertia and therefore stopping distance
Runway surface	• Landing roll is ↓ on a firm dry surface compared with a grass or wet surface due improved braking action
Slope	• Up-slope ↓ LDR, and down-slope ↑ LDR
HWC	• When wind at an angle to runway, the HWC needs to be calculated
Wind	• If strong or gusty winds, always possibility of windshear on the approach • Approach and V_{TT} speeds are increased to counter the possible effects of windshear

Calculation

- Information from Flight Manual and AC91-3
- Calculated landing distance from 50 ft assumes correct speed at 50 ft and stated flap setting is used
- LDR includes distance to touch down from 50 ft over the threshold and the ground roll to a full stop
- Crossing the threshold higher than 50 ft, using less than full flap, or crossing the threshold at a higher airspeed, will increase the landing distance

Airmanship

- Additional decision-making required in relation to strong/gusty wind and EFATO – immediately and positively lower the nose

Aeroplane management

- Full power before brake release – check static RPM
- If static RPM not achieved could be due
  - Icing
  - Instrument error
  - Propeller damage
- Get problem checked

Air exercise

Take-off

- Hold brakes on (nosewheel straight), elevator neutral, apply full power. Static RPM, Ts and Ps checked
- Clean brake release, take the weight off nosewheel – check for normal acceleration
- Hold nosewheel on ground until V_R
- At V_R smoothly rotate and lift off. Lower nose and accelerate to V_{TOSS}
- Reaching V_{TOSS} adjust attitude and hold, keep straight on reference point
- At safe height accelerate to best RoC (V_Y) or normal recommended climb speed. Check balance
- Before raising flap,
  - safe height,
  - safe airspeed, and
  - a positive rate of climb
- When these conditions have been met, raise flap and counter the pitch change. Allow acceleration to continue, and upon reaching the climb speed required (best rate or normal), trim to maintain the appropriate attitude

Landing

- Downwind, confirm approach and threshold speeds and choose aim point
- Slightly delay turn onto base to ensure some power must be used throughout approach
- Monitor approach path by reference to the aiming point and adjust power to maintain a steady rate of descent – power controls RoD
- Established on final, select full flap and decrease airspeed by adjusting attitude
- Achieve nominated V_{TT} by 200 ft AGL
- It is important to carry some power into the flare
- If the aeroplane is not properly configured by 200 ft AGL – go around!
- The round-out and the hold-off are combined into the flare
- Aim to reduce the rate of sink to zero at the same time as the main wheels touch the ground and the throttle is closed
- Lower the nosewheel, brake immediately, keep weight off the nosewheel with elevator backpressure
- Raise flap on completion of the landing roll

Human factors

- Vision affected by high nose attitude
- During approach perception may be influenced by visual cues of surrounding terrain, a false horizon, or runway length and width
- Cross-reference instruments regularly

Low flying introduction

Commonly, low flying refers to any flight at or below 500 feet AGL that may be practised only in designated low flying zones.

It's important for the student to be exposed to operating close to the ground, not only when forced to fly low, but also when mountain flying. Maintaining good situational awareness should eliminate the need for low flying due to poor weather.

Low flying improves the student's awareness of terrain and the effect of wind. Good aviation practice requires that a pilot should never fly lower than they must, but each take-off and landing involves low flying operations, when the recognition of potential visual illusions is critical.

This exercise allows the student to observe the effects of inertia, experience the visual illusions caused by drift and a false horizon, and recognise that the stress of low flying is a situation to avoid.

These lessons will not make anyone an expert at low flying. Setting personal limits well above the legal minimum should be stressed. Recap the importance of always leaving a way out, and turning back or landing at the nearest suitable aerodrome, long before the situation simulated in this exercise is reached.

Whether the designated low flying zone (LFZ) is over water or not, limited value will be found in this lesson if winds are less than 10 knots.

Objective

To compensate for the effects of visual illusions, inertia, and stress when operating the aeroplane close to the ground.

Introduce the poor visibility configuration.

Considerations

Inertia

The effects of inertia, and the sensation of speed, become most apparent at low level. At normal cruise speeds, the degree of anticipation and the amount of horizontal airspace required to turn the aeroplane is substantial.

Visual effects

The effect of wind is very apparent at low level and this can lead to quite powerful visual illusions.

When flying into wind at a constant airspeed, the groundspeed is low and this can lead the student into either lowering the nose or increasing power.

Downwind, the groundspeed is high, and this may result in the nose attitude being raised or power reduced.

When flying across the wind, the effect of drift is most noticeable. A suitable reference point on track must be chosen. In order to track towards this reference point, the appropriate amount of drift must be offset and balanced flight maintained. Avoid any tendency to fly with crossed controls.

When turning from into wind to downwind, an illusion of slipping into the turn will occur and likewise, when turning from downwind into the wind, an illusion of skidding out of the turn will occur. The strength of this illusion increases in proportion to the wind strength. Never attempt to correct an apparent skid or slip with rudder. Cross-reference to the balance indicator during low-level flight is vital.

Discuss the effects of inertia at low level in anticipation of any required manoeuvring.

Many designated low flying zones are over water, and flight over calm water, with its lack of texture, produces depth perception problems (empty field myopia). For this reason, low-level flight over water in less than 10 knots of wind is not recommended.

The poor visibility configuration

The poor visibility configuration for your aeroplane should be stated and its benefits explained.

In the poor visibility configuration, the airspeed is reduced, flap is extended (generally 15 to 20 degrees depending on aeroplane type (refer CFI)).

The benefits are as follows.

Reduced airspeed

This means less momentum and a lower groundspeed, allowing more time to think and react to obstacles, as well as reducing the radius of turns.

Flap

Flap increases the lift and drag and adversely affects the L/D ratio. The increased lift results in a decreased stall speed, allowing safe flight at the lower airspeed. The adversely affected L/D ratio means a relatively high power setting must be used to maintain straight and level flight. Use of flap has the added advantage of achieving a lower nose attitude for enhanced visibility.

Power

Maintaining the RPM in the normal range means that the continuous use of carburettor heat is not required, and operating temperatures and pressures should remain within their normal ranges. However, prolonged use of this configuration may lead to increasing oil temperature.

Power also reduces the stall speed and provides slipstream. Slipstream not only provides additional effectiveness to the rudder and elevator (for most aeroplanes) but also helps to clear the windscreen in drizzle.

Remember from the turning lessons, power must always be increased in turns. The level of power required increases as the angle of bank increases.

Low flying zone

Management of the exercise requires a careful inspection of the low flying zone and preparation of the aeroplane before entering the area.

Low flying must take place within the boundaries of a designated low flying zone. The boundaries of the area should be described with reference to a VNC and the minimum descent height stated. Flight below 200 feet AGL is not recommended (refer CFI).

If low-level flight is to be conducted over water, lifejackets should be worn, not just carried in the aeroplane.

A broadcast or report, including the estimated elapsed time (EET) to be spent in the zone must be made on entering – and a vacating report when leaving.

Airmanship

When flying close to the ground, if the aeroplane's high speed and inertia are combined with conditions of poor visibility, there is little time to react to obstacles or plan a course of action. Therefore, to better manage the flight, the use of the poor visibility configuration is recommended.

It should be noted that most low flight will be in the normal cruise configuration. The need for training in the operational application of the poor visibility configuration is relevant but raises the questions: "Have I gone too far?" "Should I turn back?" "Should I take an alternative route?" "Should I consider a precautionary landing?".

The use of the term poor visibility rather than bad weather configuration is recommended, because bad weather is not necessarily perceived by the student as poor visibility. If the weather is otherwise fine but the aeroplane is experiencing severe turbulence (where the aeroplane's structural load limits may be exceeded), the student may consider this to be bad weather! However, in such situations, if the poor visibility configuration is selected, extending flap usually reduces the aeroplane's maximum structural load limits (refer Flight Manual).

For this purpose, many organisations adapt the HASELL checklist, adding an extra L for lights (refer CFI).

H Height *(not altitude)*

Height not below 200 feet above ground level (refer CFI).

A Airframe

State the configuration.

S Security

No loose articles, harnesses secure (life jackets).

E Engine

Fuel on fullest tank, fuel pump ON, mixture RICH, and a full SADIE check is completed. Check for carburettor ice.

L Location

The boundaries of the low flying zone are positively identified.

L Lookout

Look into the area for indications of wind direction and strength, possible causes of turbulence (tall trees or cliffs) and downdraughts, other aircraft, birds, obstructions (especially wires) and suitable forced landing sites – as little time for field selection will be available from low level.

L Lights

Turn on all external lights, especially the landing light.

Since ordinarily there would only be one aircraft in the low flying zone at a time, the student may be wondering, why turn on the landing light? The reason is that birds have been shown to be more sensitive to bright lights than moving objects. This is one reason why landing lights are commonly used below 1000 feet during take-off and approach.

Aeroplane management

Carburettor heat is cycled more often throughout low flying.

Fuel management needs to be considered if additional power is required to control speed or overcome the drag associated with the use of flap.

Human factors

Discuss the difficulty of detecting obstructions at low level (wires, birds) against a cluttered background.

Discuss the need to be aware of low flying sensations and potential illusions. Challenge any mindsets to help avoid the need for reactive actions because visual cues have been misleading.

Flying the aeroplane close to the ground in poor visibility is a very stressful situation. The poor visibility configuration increases the time available for processing. High stress levels result in a decrease in performance and may cause a narrowing of attention by fixating on one instrument or aspect, and/or hyperventilation.

Avoiding bad weather will eliminate one reason for low flying altogether.

Air exercise

Low flying zone boundaries

Complete the HASELLL checks and at 1000 feet AGL fly around the edge of the LFZ.

Using a powered descent, enter the LFZ at 500 feet AGL.

Visual illusions

At 500 feet AGL, it can be hard to identify the horizon, unless you are over water, so the horizon will need to be mentally superimposed over the terrain. This will be covered in more detail in the **Basic mountain flying** lesson.

The most common illusions are those caused by wind. Look specifically at the effect wind has on turning radius, and how to track over the ground with a crosswind. In addition, you should note the effects of flying upwind and downwind on the groundspeed.

The effects of inertia

Maintain straight and level at 500 feet AGL and note the time for the aircraft to react to control input.

Complete medium level turns and note the reaction times required and the radius of turn.

3-D effect

At lower levels the three-dimensional effect of terrain and obstacles is more apparent. In this light, such things as wires, sun strike, shadows, and mechanical turbulence need to be discussed.

Poor visibility configuration

Reduce the power to _____ RPM (refer CFI) while maintaining straight and level flight, and when the airspeed has reduced to inside the white arc, lower the flap to _____ degrees (refer CFI). As the airspeed approaches the nominated configuration speed, power is increased as required, to maintain straight and level flight at the nominated speed. Trim.

The level to which the power will need to be increased varies depending on the aeroplane weight and other factors. At typical training weight and configuration this setting will be about _____ RPM.

Note the pilot has more time to respond to external threats. Caution is needed for airspeed control with flap extended.

Airborne sequence

On the ground

Make sure there are no loose objects.

The exercise

The low flying zone should be identified by the student flying around the outside the boundary at a minimum of 1000 feet AGL, keeping it on the left, or student's side, so that the student can look into the area.

The student should complete the HASELLL checks and enter the low flying zone using a powered descent.

The effects of inertia, resulting in a large turning radius and requiring anticipation, are experienced by the student in the normal cruise configuration. This is best achieved by having the student follow a winding road or river. If these features are not available within your low flying zone, flying around the boundaries at 500 feet AGL may substitute. Note that the visual impression of greater speed becomes more noticeable as height is reduced.

Level medium turns through 360 degrees may also be practised (refer CFI).

Describe the sensations and potential illusions the student may encounter.

The student should then be taught the poor visibility configuration as discussed in the briefing.

This will usually be the first time the student has ever flown the aeroplane level in this configuration. Therefore, allow adequate time for student practice (refer CFI). Remind the student of the need to use power in the turn, especially with the flap lowered.

In this configuration, the effect of visual illusions created by flying across the wind, downwind and upwind can be experienced by the student and compared with the previous cruise configuration. In addition, the visual effects of slipping into the turn when turning downwind and skidding out of the turn when turning into wind are seen.

The visual illusions caused by drift on the track made good are first demonstrated by flying along a line feature at right angles to the wind. Crossing the aeroplane's controls is avoided by choosing a reference point on which to maintain level balanced flight, and regular cross-reference to instruments – especially balance.

The effects of groundspeed changes and apparent slip or skid are commonly demonstrated by establishing a race track or circuit type pattern at less than 500 feet AGL.

Medium level turns are practised in this configuration as part of the race track or circuit pattern. Medium level turns through 360 degrees may also be practised (refer CFI).

On completion of the exercise, you may gain some insight into whether or not transfer of learning has occurred by simply asking the student to "take me home".

The student has been previously taught that, before raising flap, there are three criteria that must always be met: safe height, safe airspeed (above a minimum and accelerating) and a positive rate of climb. These will be achieved only by using full power.

Returning the aeroplane to the clean configuration, in anticipation of a climb out of the low flying zone should be treated as a go-around.

Remember to make a call vacating the LFZ.

After flight

The next lesson will look at some further considerations of low flying and additional types of turns, and why they might be needed.

Low flying introduction

Objective

To compensate for the effects of visual illusions, inertia, and stress when operating the aeroplane close to the ground.

Considerations

Inertia

- Inertia and sensation of speed seen clearly at low level
- At cruise speeds need lots of anticipation and airspace to turn aeroplane

Visual effects

- Effect of wind can lead to visual illusions
- Flying into wind, groundspeed is low → lowering the nose or ↑ power
- Downwind, groundspeed high → nose attitude being raised / power ↓
- Across the wind, drift is most noticeable. Track on reference point. Avoid crossed controls
- Apparent slip or skid when turning. Do not correct with rudder. Cross-reference balance indicator

Poor visibility configuration

- Airspeed ______ kt, Flap setting ______

Reduced airspeed

- Less momentum and lower groundspeed = more time to think and react to obstacles + reducing turn radius

Flap

- ↑ lift and drag and adversely affects the L/D ratio
- ↑ lift → ↓ stall speed
- Poorer L/D ratio means higher power setting needed to maintain straight and level

Power

- Carb heat cycled not on continuously, Ts & Ps should remain within normal range
- Prolonged use may lead to ↑ oil T
- Also ↓ stall speed and provides slipstream
- Increase power in turns

Low flying zone

- Inspect low flying zone and prep aeroplane before entering
- Stay within the boundaries, do not descend below ______ ft
- If low-level over water, wear lifejackets
- On entering, broadcast EET in the zone – when leaving, make a vacating report

Airmanship

- Poor visibility configuration used

H	Height	> 200 ft agl
A	Airframe	Config stated
S	Security	Loose articles & harnesses secure
E	Engine	Fullest tank, pump ON, mixt RICH, SADIE, carb heat
L	Locality	Boundaries identified
L	Lookout	Wind indications, obstructions, birds, forced landing sites
L	Lights	All external lights ON

Air exercise

Low flying zone boundaries

- Complete the **HASELLL** checks and at 1000 ft AGL fly around the edge of the LFZ
- Using a powered descent, enter the LFZ

Visual illusions

- Superimpose horizon over the terrain
- Look at effect wind has on turning, and how to track over the ground with a crosswind
- Note effects of flying upwind and downwind on the groundspeed

Effects of inertia

- Maintain straight and level – note the reaction time needed to initiate a manoeuvre
- Medium level turns noting the reaction times required and the radius of turn

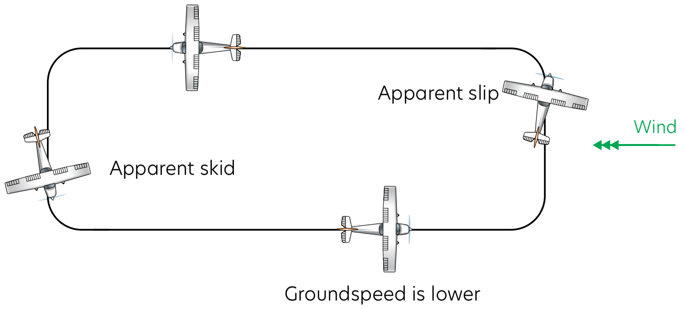
3-D effect

- Terrain/obstacles – wires, sun, shadow, mechanical turbulence

Poor visibility configuration

- Reduce power to ______ RPM, maintain straight and level flight, lower the flap to ______ degrees
- As airspeed ↓ to configuration speed, ↑ power (about ______ RPM) to maintain straight and level. Trim
- Note the reduced speed

Visual illusions



Aeroplane management

- Carb heat use
- Fuel management
- Use of power during turns with flap lowered

Human factors

- Obstructions difficult to detect at low level
- Flying close to the ground is stressful, can lead to narrowing focus
- Poor visibility configuration used to give more time
- Avoid bad weather

Low flying consolidation

Turning at low level in the poor visibility configuration is slightly different from turning in the cruise at altitude. When turning during the cruise at altitude, a reduction in airspeed or some altitude loss is not necessarily dangerous. However, at low level, low airspeed, and in the poor visibility configuration, it's vital to maintain altitude and airspeed.

The reasons for practising turning at low level is to improve confidence and flying accuracy, as well as to prepare against the possible need of operating in deteriorating weather.

Objectives

To compensate for the effects of inertia, visual illusions, and stress when operating the aeroplane in close proximity to the ground.

To carry out various level turns in the poor visibility configuration.

Considerations

Perspective

The observation of ground features is changed from a plan view to more of a profile view. This can make map reading and navigation more difficult due to a reduced radius of visible features, and in hilly terrain may obscure the true horizon. In this situation, the horizon will need to be estimated and more frequent cross-reference to instruments made to confirm performance.

Sloping terrain

During flight at low level, height above ground is estimated visually, and the altimeter is used as a secondary reference.

A dangerous visual illusion may occur when flying over gently rising terrain. As the ground gradually slopes upwards, there is a tendency to align the aeroplane with the slope so that the impression of level flight is maintained. If the airspeed indicator and altimeter are not cross-referenced regularly, the aeroplane may eventually be brought to the stall. This situation can be particularly dangerous if only the reduction in airspeed is observed. In an attempt to compensate for the decreasing airspeed, the pilot increases the power, until a turn away from rising terrain is forced on the pilot at low airspeed and full power – usually resulting in a stall in the turn.

Terrain rises steeply in New Zealand, with the gradient of a significant proportion exceeding the climb performance of the average training aeroplane.

Mechanical turbulence

Avoid flying in the lee of hills or ridge tops where turbulence and downdraughts are most pronounced.

As will be discussed in **Terrain and weather awareness** and in **Basic mountain flying**, avoid the centre of a valley because, if a decision to turn back is made, regardless of which way the turn is executed, the maximum turning space will not be available.

When in a valley, fly according to right-of-way rules, ie, right side of the valley, unless attitude and altitude are challenged. Then fly on the upwind side of hilly terrain, or updraught side of valleys, where relatively smooth updraughts can be expected. If a turn back is required, the full width of the valley is available for turning, minimising the turn radius.

Crossing obstacles

Power lines should always be crossed at the pylons. The pylons are easier to see, and there can be no wires above the pylons or the aeroplane. Many high-tension power lines have a very thin earthing wire stretched between the pylons, well above the main cables. It's very difficult to see these.

Ridges should always be crossed at an oblique angle. This method requires less bank angle if a turn away from rapidly rising terrain or downdraughts is required.

Crossing ridges and passes is covered in more depth in the **Terrain and weather awareness** lesson, and further in the **Basic mountain flying** lesson.

Airmanship

The boundaries of the low flying zone and the minimum permissible height are revised.

Solo flights must be specifically and individually authorised immediately before the intended flight.

Some organisations do not permit solo low flying practice at all (refer CFI).

Revise flight over water if applicable.

Make a careful inspection of the low flying zone, and prepare the aeroplane before entering the area (HASELLL).

A broadcast or report, including the estimated elapsed time to be spent in the area, must be made on entering the low flying zone. A vacating report must be made when leaving.

Aeroplane management

Restate the poor visibility configuration for your aeroplane. Re-emphasise that good management of the whole flight should negate the need for using the poor visibility configuration.

Prolonged use of the poor visibility configuration may affect flight planning (fuel reserves or daylight) and engine operating temperatures. Use SADIE more frequently.

Human factors

Be aware of the visual illusions created by drift, and maintain a regular crosscheck of instruments, especially the balance indicator.

Air exercise

Medium turn

When entering a medium turn in normal cruise, the angle of attack is increased by increasing backpressure to maintain height, and the reduction in airspeed is ignored, for example, 90 knots reduces to 87 knots.

When turning, even at medium angles of bank, in the poor visibility configuration, no reduction in airspeed is acceptable. Therefore, in order to maintain the nominated configuration speed, increase the power.

The required power increase for a medium turn is generally quite small.

Steep turn

Steep turns in the poor visibility configuration are generally restricted to a maximum of 45 degrees angle of bank. There are two reasons for this.

Firstly, as covered in the **Steep turns** lesson, the increase in drag and the stalling speed are not proportional to angle of bank but are exponential. Therefore, as the angle of bank increases beyond 45 degrees, both the stalling speed and drag rapidly increase.

With the aeroplane already operating at a low airspeed, there is little margin for an increase in the stalling speed. In addition, the amount of power required to maintain altitude at angles of bank greater than 45 degrees may not be available as a result of the rapidly increasing drag.

The second reason involves the aeroplane's structural limits. Most aeroplanes have a reduced maximum G-load limit when flap is extended. For example, the PA38 is limited to +2.0G when flap is extended, and this G loading is reached at an angle of bank of 60 degrees.

When entering the steep turn from normal cruise, backpressure is increased to maintain altitude and, although the increase in drag is not ignored beyond 30 degrees angle of bank, some decrease in airspeed as a result of the substantially increased drag is expected and acceptable.

When entering the steep turn at low level in the poor visibility configuration, however, absolutely no decrease in airspeed is acceptable, because of the small margin over the stalling speed.

To maintain this margin over the stall speed, power is increased on entry – the power increase required may be substantial, although not necessarily full power.

During the turn, attitude, angle of bank, speed, and balance are monitored.

If altitude is being lost, reduce the angle of bank, increase power if necessary. If full power has been applied and altitude is still being lost, there is only one option available – further decrease the angle of bank – quickly!

On exiting the turn, power is reduced in anticipation during the rollout, keeping the airspeed constant.

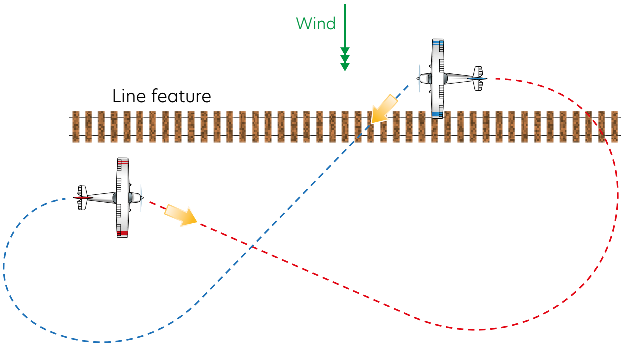
Obstacle avoidance or reversal turn

This is a 180-degree turn to avoid an obstacle or poor weather ahead. The direction of the turn is dictated by the wind, but in nil wind conditions turn left or right to maximise visibility.

It's common practice during basic training to simulate the worst case scenario. Therefore, this exercise assumes a line feature is being followed (road, river, or railway line) in conditions of poor visibility and an obstacle appears ahead, or a decision to turn back is made (see Figure 1). A turn 45 degrees off the line feature downwind is made to allow sufficient space to turn back into wind, to cross the line feature and return with the feature on the left is recommended (an allowance for drift may be required).

Figure 1

Reversal turn



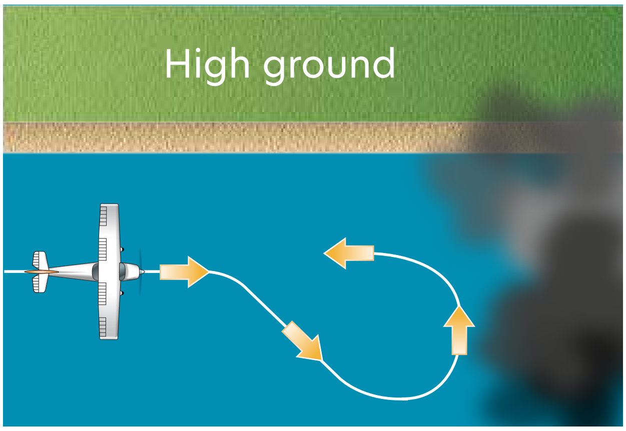
It's important to maintain visual contact with the line feature throughout the manoeuvre.

Note, however, that an earlier decision to turn back, probably in conditions of better visibility, may have required only a medium turn.

Coastal reversal turn

Figure 2

Coastal reversal turn



Once again the worst case scenario is simulated. An obstruction ahead or weather requires a turn back when the feature being followed is the coastline. Simulated poor visibility means no definable horizon is available seaward, and the coastal terrain is simulated as being higher than the aeroplane (see Figure 2).

The aim of this manoeuvre is to keep the reference (the coast) in sight throughout the turn to seaward and then track back along the coast in the opposite direction.

This procedure should not be confused with an instrument procedural turn. The coastal reversal turn is a totally visual procedure, with cross-reference to instruments being only for accurate flight. Throughout the procedure, the reference (the coast) must be kept in sight.

The wind direction and strength will determine which heading is chosen to track away from the coast to provide enough space to complete the reversal turn.

With the wind parallel to the coast (head or tailwind), a turn away from the coast of about 45 degrees is recommended. This may be backed up by a DI heading or simply estimated. Keep the coast reference in sight and track out far enough to ensure sufficient space to complete the turn.

If the wind is offshore, and depending on wind strength, tracking out at a lesser angle and/or a shorter time is used to remain closer to the coast while still ensuring sufficient space to complete the turn.

If the wind is onshore, tracking out at a larger angle is not generally recommended because of the difficulty in keeping the reference in sight. However, if the coastal terrain so dictates, there will be no choice. This is a good reason to turn back well before the situation deteriorates to this degree.

The angle of bank used in the initial turn away from the coast will be influenced by the pilot's ability to keep the reference in sight. If the coastline is on the left-hand side, a larger angle of bank can be used than if the coastline is on the right-hand side.

When the distance out has been assessed as enough, the turn is reversed, turning toward the reference (coast) to keep it in sight.

In this reversal, a steep turn should be entered, and as soon as it's obvious that the turn can be completed within the space available, the angle of bank can be reduced.

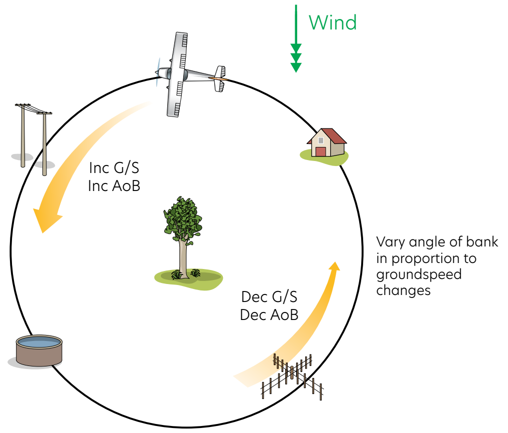
Starting the reversal with a medium turn is not recommended. If it becomes obvious that a steeper angle of bank will be required, this may not be possible while maintaining altitude.

Constant radius turn

The aim of a constant radius turn is to counteract the effects of drift while turning in order to maintain a constant distance from a ground reference.

Figure 3

Constant radius turn



It's simplest to identify four points equidistant from the feature/reference point to scribe a circle around (see Figure 3). Maintain a constant radius by overflying each of the four points on the circle, applying the principle; increasing groundspeed, increase angle of bank, decreasing groundspeed, decrease angle of bank. This will account for the drift.

Airborne sequence

The exercise

The medium turns can be practised by the student, and depending on the student, they may be able to practise steep turns without a demonstration from you.

Demonstrate the obstacle avoidance or line feature reversal turn, and then the student should practise.

Taking into account the wind direction and strength, discuss the manoeuvre with the student before you demonstrate the turn in both directions. The student can then practise as you talk them through, followed by their own practice.

Repeat for coastal reversal turn scenario.

Demonstrate the first constant radius turn and from then on the student should be able to practise this with coaching from you.

After flight

The next lesson will be using the newly acquired low flying skills and should be **Precautionary landing**.

Low flying consolidation

Objectives

- To compensate for the effects of inertia, visual illusions and stress when operating the aeroplane in close proximity to the ground.
- To carry out various level turns in the poor visibility configuration in response to deteriorating weather.

Considerations

Perspective

- Ground features look different – plan view to profile view
- Need to estimate horizon – cross-reference instruments

Sloping terrain

- Height above ground estimated visually – altimeter secondary reference
- Gently rising terrain – cross-reference airspeed indicator and altimeter

Turbulence

- Turbulence more pronounced, updraughts and downdraughts more significant
- Avoid flying in the lee of hills or the centre of valleys
- Fly on the upwind side of hilly terrain, or updraught side of valleys

Crossing obstacles

- Cross power lines at the pylons
- Cross ridges at an oblique angle

Airmanship

- Revise boundaries of LFZ and minimum height
- Solo flights must be authorised, and only one aircraft in LFZ
- Make careful inspection of LFZ, and **HASELLL** checks
- Broadcast on entry and exit

Aeroplane management

- Poor visibility configuration
- Prolonged use of the poor visibility configuration may affect fuel reserves and engine operating temperatures
- Use **SADIE** more frequently

Human factors

- Visual illusions created by drift
- Maintain a regular crosscheck of instruments, especially the balance indicator

Air exercise

Medium turn

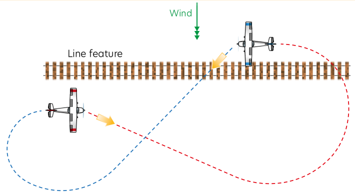
- In poor visibility configuration, do need a small increase in power to maintain the airspeed

Steep turn

- In poor visibility configuration steep turns limited to 45° because
  - drag and stall speed increase exponentially beyond 45° AoB, and as power is limited, may not be able to maintain the airspeed
  - The G-load limit is lower with flap extended
- No decrease in airspeed is acceptable so power is increased substantially at the roll in
- Monitor attitude, angle of bank, speed, and balance
- If altitude is being lost, reduce the angle of bank, increase power if necessary
- Anticipate roll out and coordinate power reduction

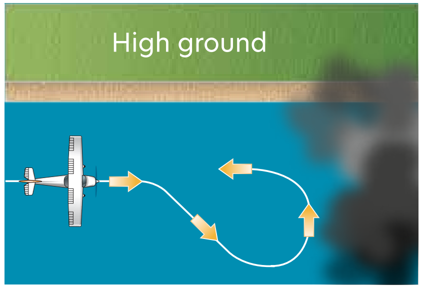
Obstacle avoidance

- Simulate the worst case scenario
- Following a line feature in poor visibility an obstacle appears ahead
- Drift downwind at 45° to line feature to turn back into wind, completing the turn with feature back on the left



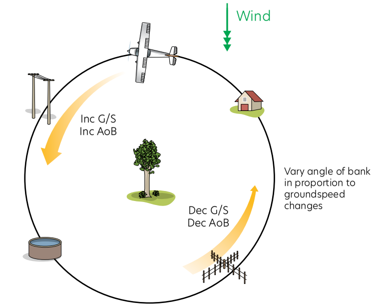
Coastal reversal turn

- Need to turn back, no horizon out to sea, high ground along the coast
- Must keep the coast in sight throughout the turn seaward and then track back along the coast
- Wind direction and strength determines heading needed to track away from the coast to provide enough space to complete the turn
- Headwind or tailwind – turn 45° away from coast. Compensate for crosswind by increasing or decreasing the 45° – do not lose sight of the coastline
- Angle of bank used depends on ability to keep coast in sight
- Continue away from shore until enough distance available to turn back
- Start turn with 45° AoB and reduce if not needed



Constant radius turn

- Adjust AoB to compensate for drift to maintain constant distance from object on surface
- Identify 4 points equidistant for reference to overfly
- As turn down wind, groundspeed increases, so increase AoB
- Turning crosswind again, groundspeed decreases, so decrease AoB
- Turning into wind, groundspeed decreases, so decrease AoB
- Turning crosswind again, groundspeed increases, so increase AoB



Precautionary landing

This exercise discusses the procedure to follow in the event of needing to land somewhere other than a recognised aerodrome for the reasons discussed below.

It differs from the forced landing because the aircraft has power and it's possible to choose the most appropriate landing site for the circumstances.

If, due to a lack of situational awareness and/or poor flight planning, the pilot becomes hopelessly lost, is running out of fuel or daylight, or is forced to fly in conditions of poor and deteriorating visibility, they may need to consider landing anywhere suitable.

If for any reason pilots find themselves in this situation, they should accept the mistake – and not make another one by pushing on.

The decision to make a landing off-aerodrome will create considerable stress. However, the longer the landing is put off, the more limited the options.

Avoid this whole situation by careful pre-flight planning and by choosing to turn back or divert early.

Objective

To learn the procedure to adopt in the event of an off-aerodrome landing.

Considerations

The reasons an off-aerodrome landing may be required are discussed, with particular emphasis on recognising approaching threats early to avoid these situations.

Weather

Pushing on into deteriorating weather is the most common cause, and is the easiest to avoid.

Avoid this situation by setting personal meteorological minima well above the legal minimum. Have a careful consideration of the weather before any flight, and always have an escape plan. See the *VFR Met* GAP booklet for more strategies.

Lost

Becoming hopelessly lost would not necessarily require the implementation of this procedure, but it's considered here in conjunction with one or more of the other reasons.

Becoming lost is avoided by maintaining situational awareness and careful pre-flight planning.

Fuel

Running out of fuel, which may result from becoming lost or trying to get around weather, rather than diverting early, is a situation that will heighten any existing stress levels.

Careful pre-flight planning and in-flight fuel monitoring will help avoid this situation.

Daylight

Most organisations require all aeroplanes to be on the ground, or in the circuit, 30 minutes before Evening Civil Twilight (ECT). Plan to start early and avoid ECT issues.

If any of the above situations have developed, the recommended procedure is to adopt the poor visibility configuration and carry out an off-aerodrome landing. To execute the recommended procedure may take about 15 to 20 minutes, so a timely decision to avoid additional stress is recommended.

Airmanship

Making an early decision to land gives more time available to make the plan.

Continued wind awareness.

The appropriate passenger briefing and security checks are carried out.

In the real situation make a PAN call and squawk 7700. If the outcome doesn't look favourable you may wish to make a MAYDAY call (refer CFI). Consider activating the ELT.

As with all low flying, more frequent use of SADIE checks is advised.

The minimum descent altitude for this exercise is restated (refer CFI).

Aeroplane management

Consider the poor visibility configuration to slow things down and allow for the increased stress. If the landing is because of bad weather, carburettor heat needs to be considered. If it's due to a low fuel state, manage the landing within the available fuel.

Human factors

When flying at low level or in reduced visibility, disorientation can quickly occur. The student will need to make an enhanced effort to remain orientated.

Stress has a significant effect on decision making, situational awareness, mental workload, problem solving, and performance. Minimising stress involves good aviation practice to avoid the situations that call for this procedure, overlearning the procedure to deal with it, and applying effective stress management techniques.

Air exercise

This exercise is carried out in the low flying zone, unless this is over water. The low flying zone pre-entry checks and radio calls are made. If the exercise is to be simulated by maintaining 500 feet AGL outside the low flying zone, amend the briefing as required.

Simulating the conditions

Descending to 500 feet AGL simulates a lowering cloud base and reduced visibility. The poor visibility configuration is adopted, and the decision to land off-aerodrome is simulated.

With the decision made to discontinue the flight, a search for a suitable landing site is initiated, the emergency is declared, and the passengers and cabin secured.

Assessment of the wind is based on the same indicators as the forced landing, with the importance of drift increased.

Landing site selection

Revise the 'seven S's, C and E': size, shape, slope, surface, surrounds, stock, sun, communication and elevation. Power will be used to maintain an estimated height above ground level, but avoid operating unnecessarily low, as this will only increase stress levels.

If time permits, a suitable landing site with ground assistance nearby can be chosen.

The position of the sun may be a major factor in the choice of a suitable landing site, especially if the onset of ECT is the reason for landing.

The length of the landing site can be assessed by flying into wind, from fence to fence in the direction of landing and timing how long it takes. Two knots is equal to approximately 1 metre/second. Assuming the airspeed is 70 knots, then groundspeed is about 70 knots. If the time it takes to fly the length of the landing site is 10 seconds at 70 knots, then that is approximately equal to 350 metres. If the basic landing distance is known the landing site can be assessed as suitable or not.

Alternatively superimposing a known and acceptable image over the selected site such as "looks about the distance between the threshold markers and the 500-foot markers of the home aerodrome", ie, 150 metres.

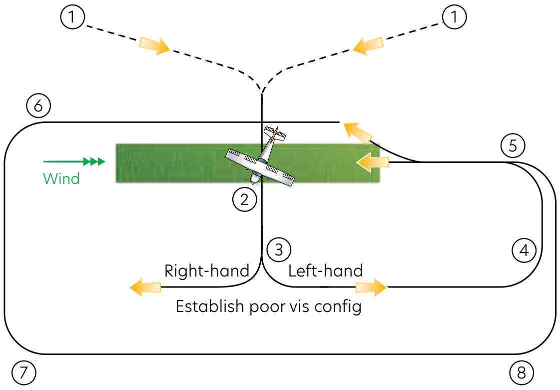
The pattern

Once a landing site into wind has been selected for closer inspection, flying overhead at right angles to the landing option/vector can help determine if a left or right hand circuit is the best option (see Figure 1). It will also confirm the wind assessment through drift, and provide an opportunity to look at the approach and overshoot paths before any descent. It may also provide cues to help identify any gradient.

In low cloudbase situations, it's recommended that the circuit altitude be established at about 100 feet below the cloud base. This provides both maximum visibility and ground clearance.

Figure 1

Pattern for a precautionary landing
(see whiteboard layout for key to numbers)



Ideally, the aeroplane is positioned into wind at 500 feet AGL, with the chosen landing site on the left-hand side, far enough out so the pilot can look across at the landing site and assess it in relation to the 'seven S's, C and E'.

On this and subsequent legs, the chosen landing site is assessed in relation to the 'seven S's, C and E', with particular emphasis on surrounds in the approach and climb-out areas.

Landmarks are chosen (if available) at the beginning and end of each circuit leg to help remain orientated in case the pilot loses sight of the landing site.

In addition, on the first upwind leg, the heading of the landing direction can be noted. To reduce mental workload, however, another less common method is to align the DI to north while on this leg, regardless of actual heading. Each leg of the required circuit will now have a cardinal heading in nil wind and the landing will always be carried out on a heading of north.

This, however, may contribute to overall disorientation. The important focus is on the chosen landing area and noting of relevant threats.

On the downwind leg, spacing is assessed using the same airframe reference as a normal circuit. Since the short field landing technique will be used, the downwind leg is extended – visibility permitting.

At the end of the downwind leg, a ground feature (if available) is selected as a turning point reference.

Assuming the chosen landing site appears suitable up to this point, a second inspection is carried out at a minimum of 200 feet AGL.

The base leg is extended through the centreline and the aeroplane turned into wind, with the landing site on the left-hand side, but closer than during the first inspection. This inspection is to decide exactly which side or part of the landing site will be used for the landing roll. Are there any tree stumps in the long grass?

Established on and parallel to final, a gradual descent to a minimum of 200 feet AGL is carried out.

Descent below 200 feet AGL is not recommended, because it takes considerable concentration to fly the aeroplane level and look at the landing site surface. Also, there is a possibility of unseen obstructions, and since a climb to 500 feet AGL will be initiated on completion of this inspection, the climb is minimised. Unless committed to the landing, never descend below the highest obstacle in the go-around path.

The major portion of the aeroplane's momentum will be spent in the first two thirds of the landing roll. Therefore, it's generally recommended that the low-level inspection is not prolonged, but a climb to 500 feet AGL initiated about two thirds of the way along the landing site (refer CFI).

Ensure the decision points for the approach and aim point are easily identifiable because, unlike a forced landing, time to go around in the event of a poorly executed approach should be available.

Climb out in the poor visibility configuration to 500 feet AGL. Generally, this climb-out is not treated as a go-around with appropriate configuration changes, because re-establishing the poor visibility configuration on reaching 500 feet AGL increases the workload.

The aeroplane is re-established on the downwind leg, the passenger briefing is completed, and a short field approach and landing is carried out.

The landing

During the landing roll, use braking as required, avoid major obstacles and above all else, keep the cabin intact.

After landing, the shutdown checklist is completed.

Airborne sequence

The exercise

The student should be capable of positioning the aeroplane within the low flying zone, checks complete at 500 feet AGL, and established in the poor visibility configuration.

To inject some realism to this exercise talk the student through the scenario. The weather has deteriorated, they are not entirely sure of their position, and it's starting to get dark – they need to carry out a precautionary landing.

First they must find a suitable landing site. Have the student talk you through what they are looking for, while you fly the aeroplane. They should remember the 'seven S's, C and E' from previous lessons and the briefing.

Take some time to discuss all of the elements. Although a time constraint may be introduced in later flights, allow the student enough time to complete the recommended inspections.

Now set the aeroplane up in the pattern. Choose the landmarks, note the heading of the landing direction, descend to 200 feet for the closer inspection, and time the downwind leg to calculate landing distance available.

Consider the decision making points for the approach and aim point. If they are not achieved a go-around will need to be executed to reposition for another approach.

Continue the circuit and set it up to land. The height at which you execute a go-around will be determined by your CFI.

Now let the student practise, while you monitor their progress.

After flight

Re-emphasise to the student that this is a last resort procedure, and the best course of action is not to get themselves in this position in the first place.

Precautionary landing

Objective

To learn the procedure to adopt in the event of an off-aerodrome landing.

Considerations

Cause	Avoidance
Weather	• Avoid by setting personal meteorological minima well above the legal minimum • Have a careful consideration of the weather before any flight and always have an escape plan
Lost	• Avoid by maintaining situational awareness and careful pre-flight planning
Fuel	• May result from becoming lost or trying to get around weather, rather than diverting early • This situation will heighten any existing stress levels • Avoid by careful pre-flight planning and in-flight fuel monitoring
Daylight	• This organisation requires all aeroplanes to be on the ground, or in the circuit, 30 minutes before Evening Civil Twilight (ECT) • Start early, finish early

- If these situations arise, adopt poor visibility configuration and carry out an off-aerodrome landing
- This can take 15–20 minutes to complete – don't leave it too late

Air exercise

- In low flying zone
- Low flying area pre-entry checks and radio calls
- Secure pax and cabin
- Descend to 500 ft AGL, adopt poor visibility configuration
- Decision to land simulated
- Start search for suitable site
- Declare emergency

Pattern

① Search and approach to cross centre at right angles

② Observe drift – confirm wind assessment
  - Establish left/right hand circuit at 500 ft – or 100 ft below cloud base
  - Position so that the site can be seen and evaluated
  - Check approach/overshoot while height available
  - Consider gradient cues

③ Radio call if not already completed
  - Pax brief
  - Checks

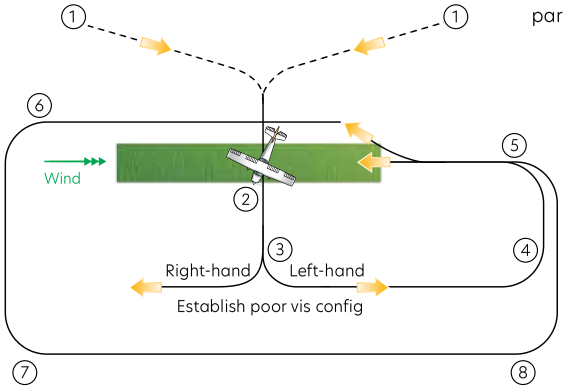
④ Check:
  - approach
  - obstacles
  - wind
  - go-around point
  - alignment
  - Choose landmarks, if available, particularly one at end of downwind

⑤ Descend to 200 ft
  - check Ss, C, and E as appropriate
  - assess length of paddock by timing or by superimposing known image
  - note heading or set DI to North
  - aim point
  - overshoot options

⑥ Climb

⑦ Confirm:
  - radio call
  - pax brief
  - checks
  - normal circuit spacing

⑧ Establish short-field approach



Landing

- Use short field technique
- Use braking as required
- Avoid obstacles
- Keep cabin intact
- After landing, shutdown checklist

Airmanship

- Make early decisions – time to plan
- Wind awareness
- Passenger briefing and security checks
- PAN call and squawk 7700. Possibly MAYAY call
- **SADIE** checks
- Minimum descent altitude

Aeroplane management

- Consider poor visibility configuration
- Fuel – avoid exhaustion before landing achieved

Human factors

- Disorientation due low level
- Stress
- Overlearn the procedure

Terrain and weather awareness

This training should expand on the syllabus requirements of low flying to incorporate an increased level of experience and understanding of flying near terrain and its associated weather, especially wind.

Fundamental to safe flight near terrain is the ability to establish an appropriate horizon reference when the visual horizon is not available because of terrain or weather.

It's important to develop the student's awareness of space and inertia while they are operating in a confined space using an imaginary horizon.

These exercises do not require high mountains to establish the basic principles.

The introduction exercise could be completed in most low flying zones. Where this is not possible flying at 500 feet AGL above an open area with a definable 'confined area' of approximately 500 metres x 500 metres will meet the requirements. This is followed by replicating the exercise within a valley, where a real horizon is not available.

Opportunities for scenario based decision making, and recognition of threats in context, should be maximised.

Terrain awareness training should focus on recognising the significance of weather, especially wind, relative to the terrain and its impact on flight conditions and flight path.

Objectives

To establish a useable horizon reference when the actual horizon is not available.

To operate in a confined area.

To develop further awareness of space and inertia when confined by terrain.

To safely cross ridges, saddles, passes or spurs.

Considerations

The student should experience the exercises in a variety of configurations and conditions:

1. In both the clean configuration, and poor visibility configuration.
2. In both calm and light wind conditions (less than 15 knots).
3. In clear conditions, and with some precipitation.
4. They should complete turns through 180 degrees and 360 degrees both clockwise and anticlockwise.

Superimposed horizon

Define the horizon as where the sea meets the sky.

Identify the real horizon.

An imaginary horizon can be used when the real horizon is obscured by terrain or weather. The horizon can be imagined by visualising the obstruction (terrain or weather) as transparent, and visualising where the sea would meet the sky.

Operating in a confined space

Define a simulated confined area, free of obstacles and with clearly defined boundaries. A flat paddock of approximately 500 metres x 500 metres would suit most light training aircraft.

Define a similar area in a location where a clear horizon is not available.

Discuss how to superimpose the horizon when the real one can't be seen.

Identify a useable imaginary (or real) horizon by visualising where the sky meets the sea, as if the terrain or obstacle to the visual horizon were transparent.

Use this horizon line to reference the nose attitude, whether in straight and level flight or level turning flight.

Review wind cues and how to estimate drift, as covered in the low flying lessons.

Discuss varying the angle of bank in order to use all the available space, and the use of power to maintain a safe speed during all manoeuvres.

Discuss the importance of being aware of the wind direction and speed relative to the terrain. Demonstrate how the wind will behave in varying strengths, and how it will flow around and/or over terrain depending on its strength.

Operating in a valley

Discuss where to position the aeroplane in a valley, considering;

- right of way rules,
- lift and sink conditions,
- use of space – depending on weather and airspace conditions,
- positioning right of centre in a large valley,
- positioning on the right side in a narrow valley – so that you can immediately escape by turning 180 degrees, should it be necessary because of weather, sink, turbulence, traffic, or running out of space.

Discuss the need to use the minimum angle of bank necessary to use all the space. This will also minimise the stall speed and improve the potential for anticipation by allowing more time to assess factors such as, horizon, space, inertia, rate of closure, radius required, turbulence, etc.

The poor visibility configuration will slow the aeroplane down and reduce the turn radius. Consideration of a reduced flap selection may be required to maintain aeroplane performance.

It's important to remember that this exercise is not a minimum radius turn. If a minimum radius turn is required, a good decision is long overdue.

Discuss the use of check turns to assess the available space well before committing to any area the student is unsure of.

Crossing ridges, saddles, passes, or spurs

Students will need to take into account all aspects of the crossing including the approach to the crossing, the actual crossing, and the flight path after the crossing.

When planning a crossing, the approach angles must take into account the effects of wind and terrain, and allow escape options throughout the crossing, that minimise the period of commitment – a 45-degree angle, or less, is ideal.

The aeroplane must be in level flight, speed under control; not in a climb where visibility and airspeed are compromised; not in a descent where V_A may be compromised in turbulence at the saddle and loss of altitude may compromise return options back over the saddle.

The student should be able to use parallax to help recognise the aeroplane's height in relation to the saddle.

If the terrain beyond the saddle is disappearing, the aeroplane is not high enough. If the terrain beyond the saddle is staying the same, the aircraft is at terrain height and 500 feet can be added for safe clearance. If there is increasing terrain beyond the saddle then the aeroplane is higher than the saddle.

Discuss how much terrain clearance is needed for a safe crossing.

Discuss the types of saddles, and their relative merits. A knife-edge saddle is the most preferable because of the shorter time it takes to cross. It allows for a shallow angle of approach (45 degrees or less) and allows a shallow angle of escape.

It's critical that escape options are always available. The effects of weather, terrain, traffic, turbulence, sink, and confined turning radius can require the use of an escape option at a moment's notice. These escape options should be downstream, downhill and through the minimum possible angle of bank, in order to maintain a margin over the stall in anticipation of potential sink or turbulence.

Airmanship

Thinking ahead of the aeroplane is an important part of this exercise. In the real situation it will ensure that the student does not find themselves forced into reacting to an unforeseen situation.

Good decision making is critical, especially crossing ridges and passes, to maintain escape options and to minimise any commitment period.

The student must remain aware of their situation at all times, in particular remaining aware of the changing weather, nearby terrain, other traffic in the area, and their own performance.

It's helpful to make position reports both before and after crossing a saddle or pass to assist with traffic awareness.

As with any low flying, more frequent use of SADIE checks is advised.

The minimum descent altitude for this exercise is restated (refer CFI).

Aeroplane management

Revise the poor visibility configuration – considering when it's necessary to adopt, and the effect it has on performance.

Review V_A, V_S, and operating speed range considerations. Review the use of power as necessary to remain safely above stall speed, but in anticipation of potential turbulence, below the maximum manoeuvring speed.

Carburettor heat as required.

Fuel management – review leaning the mixture for engine considerations, performance and economy.

Revise control coordination to ensure smooth, balanced, handling to reduce unnecessary stress on the aeroplane, passengers and pilot.

Consider the positioning of the aeroplane in relation to the terrain while taking into account wind direction and speed, so as to mitigate the effects of turbulence.

Human factors

Good planning and situational awareness will reduce disorientation.

Discuss the illusions associated with inaccurate horizon definition, most commonly an insidiously climbing terrain gradient which tricks the pilot into raising the nose.

Potential hazards associated with illusions and poor horizon definition include inadvertently reaching the stall speed with high power and no room, or performance, available to escape.

Motion sickness can be a problem, use the I'MSAFE checklist, good planning and training to reduce anxiety levels. Use smooth coordinated control inputs, and provide sick bags as a backup.

Direct the student towards more reading on this subject, there are a number of GAP booklets that deal with flying in mountains, such as *Mountain flying*, *Survival*, the *In, out and around* series, as well as the *Mountain flying* DVD.

Air exercise

In the 'confined area' within a low flying area, fly the boundaries using a minimum angle of bank using all the available space. Control the speed with power.

Use the clean configuration and the poor visibility configuration, calm and light wind conditions, as well as no precipitation and some precipitation. Make turns left and right through 180 degrees and 360 degrees.

All opportunity to identify wind speed and direction cues should be maximised.

Repeat the exercise in an area confined by terrain without a real horizon available.

Use saddle crossing techniques to enter or exit this 'confined by terrain' area.

Refer to the *Mountain flying training standards guide*.

Airborne sequence

Operating in a confined area

Starting with a larger area, and gradually reducing to the smaller 'confined area' will help students to manage this exercise.

In the clean configuration, fly the boundaries using minimum angle of bank, using all available space. Repeat in the poor visibility configuration, noting the differences.

Ensure every opportunity is taken to enhance wind awareness, especially noting wind strength and direction.

Relocate from the obstacle free simulated confined area to a suitable valley to carry out the same exercise but near terrain, and consequently a less defined horizon. Carry out check turns before entering, and during early positioning in the valley to make sure the operation is not beyond personal limitations.

Appropriately position the aircraft to execute level 180 degree and 360 degree turns using all the available space, minimising the bank angle and using only sufficient power to maintain a safe speed between V_A and V_S – appropriate to conditions and aeroplane loading.

Crossing ridges, saddles, or passes

Determine the lift or sink sides of the saddle. Assess the approach, crossing, and after crossing options.

Approach at 45 degrees or less to provide the best escape downhill, downstream, and with the minimum angle of bank required.

Fly left to right to allow for the best visibility. However, if the escape to the right is obstructed, or the sink on approach is significant, consider flying right to left. If this approach presents too many threats, the options are to fly higher if cloud base permits or find a safer saddle.

Show the student the difference between the 'knife-edge' saddle and the flat saddle, choosing the 'knife-edge' to cross at.

Approach level and below V_A, as discussed.

Show the student how to use parallax to assess sink and their height in relation to the saddle.

Have the student gain experience in making decisions using a variety of approach options.

Terrain and weather awareness

ADVANCED MANOEUVRES

Objectives

- To establish a useable horizon reference when the actual horizon is not available.
- To operate in a confined area.
- To develop further awareness of space and inertia when confined by terrain.
- To safely cross ridges, saddles, passes or spurs.

Considerations

Superimposed horizon

- Horizon is where the sea meets the sky
- Imaginary or superimposed horizon used when real horizon can't be seen
- Visualise where sea meets sky

Operating in a confined space – valley turning

- Select a clear area 500 m x 500 m
- Select another area the same size, where there is no horizon available
- Identify imaginary horizon, as if terrain were transparent, use it to reference nose attitude
- Wind cues and drift estimation
- Use all available space by varying bank angle, power to maintain safe speed
- Develop awareness of the significance of wind velocity relative to the terrain

Crossing ridges, spurs, saddles or passes

- Consider the approach, the actual crossing, and after the crossing
- Ensure approach angles take wind and terrain into account, allow escape options that minimise period of commitment – 45° or less is best
- Attitude for crossing – level, speed under control, no climb or descent
- Use parallax to judge height above saddle
- How much clearance is required?
- Types of saddles and merits
- Escape options must always be available

Air exercise

Conditions

- Clean configuration
- Poor visibility configuration
- Calm conditions
- With wind / wind indicators
- No precipitation
- Some precipitation
- Left turns
- Right turns
- 180° turns
- 360° turns

Operating in a confined area

- Fly boundaries with minimum angle of bank
- Use all available space
- Control speed with power
- Note wind direction and speed
- Position for 360° and 180° turns
- Check turns

Confined area with no horizon

- Same exercise and conditions as confined area
- Use saddle crossing technique

Crossing ridges, saddles, passes or spurs

- Determine lift/sink side
- Approach at 45° or less for best escape options
- Left to right best for visibility and escapes
- Look at different saddles
- Approach level and below V_A
- Use parallax to assess sink and relative height
- Have escape route available at all times – other than during period of commitment

Airmanship

- Think ahead, decision making critical
- Situational awareness
- Position reports
- SADIE
- Minimum altitude

Aeroplane management

- Clean and poor visibility configuration
- Operating speed range between V_S and V_A
- Carb heat as required
- Engine leaning
- Smooth control movements
- Aeroplane position near terrain

Human factors

- Disorientation
- Visual illusions
- Motion sickness

Basic mountain flying

This training introduces students to the principles of basic mountain flying and further develops their experience and understanding of operating near terrain with its associated weather.
This is a CPL level exercise.

The exercises do not require high mountains to establish the basic principles.

Opportunities for scenario based decision making and recognition of threats in context should be maximised.

Whenever the opportunity presents itself, the training should focus on recognising the significance of weather, especially wind relative to terrain and its impact on flight conditions and flight path.

Objectives

To consistently identify a useable horizon and to mentally superimpose it on to a variable background.

To appropriately position an aircraft in a valley and to conduct level, climbing and descending turns.

To safely approach, cross, and position after crossing ridges, saddles, passes, or spurs.

Experience real or simulated circumstances of disorientation and the strategies for reorienting in place and time.

To practise emergencies where options may be limited.

Considerations

The student should experience these exercises to increase their awareness of mountain flying and the associated weather:

1. In clean and poor visibility configuration,
2. In both calm and windy conditions (greater than 15 knots, at instructor discretion),
3. In clear, and some precipitation, conditions,
4. Completing turns through 180 degrees and 360 degrees both clockwise and anticlockwise.

Wind below 15 knots is generally predictable. It's important that instructor discretion is applied in wind conditions above 15 knots, when ability to accurately predict conditions is more challenging and affected by the terrain shape, size, and presentation of airflow.

All wind speed and direction potential cues should be discussed.

Importantly, basic mountain flying requires completion of a ground course – please refer to the *Mountain flying training standards guide* for the content of this course.

Superimposed horizon

Revise the definition of the horizon.

Identify the real and imaginary horizon.

Review the illusions associated with inaccurate horizon definition, most commonly an insidiously climbing terrain gradient which tricks the pilot into raising the nose. Potential hazards associated with illusions and poor horizon definition include inadvertently reaching the stall speed with high power and no room, or performance, available to escape.

Operating in a valley

Review and expand on:

- use of check turns,
- positioning in a valley,
- turning using minimum angle of bank to use all available space,
- poor visibility configuration use and considerations.

Discuss the considerations of climbing and descending turns when entering and vacating a valley. This will help the student to experience the changing horizon perspective and consequent importance of attitude/speed control.

Discuss valley gradients – the student should experience flying at a constant height above the valley floor while descending down a valley to observe the VSI indications and predict the climb performance necessary for flight in the opposite direction. The gradient in most valleys far exceeds the climb performance of the average light training aeroplane.

Discuss the effects of sun and shade – if possible, in a controlled dual environment, expose the student to the sun suddenly appearing and disappearing behind a ridge.

Crossing ridges, saddles, passes, or spurs

Review and expand on the considerations from the **Terrain and weather awareness** lesson:

- consider all aspects of crossing,
- configuration and attitude of aeroplane,
- effect of wind and terrain,
- escape options,
- use of parallax, and
- types of saddles.

In increased wind conditions the student will need to assess the areas of lift and sink, and areas of potential turbulence for all phases of a crossing.

The student must consider the approach path or angle from well before the crossing. They must assess the approach angle (left to right or right to left) for wind, cloud and turbulence conditions, and provide for the best escape option at all times.

Escape options should be available through a shallow angle (45 degrees or less) to minimise the angle of bank and consequent V_S. The best escape option should provide for a downstream, downhill escape on both sides of the crossing to anticipate the effects of potential turbulence or sink.

The student should experience as many options as possible, including those that may not be the best, provided that the experience stays within the instructor's limitations.

Route finding

Discuss the importance of good planning and map preparation. Time spent on the ground significantly reduces workload in the air, especially in the mountains where a good lookout is more critical because of proximity to terrain.

Being able to identify the direction of water flow/gradient will help greatly when it's critical to be assured of the aeroplane's position. The student should develop the skill of recognising flow direction and by assessing the amount of white water present, gain a clear indication of valley gradient.

Being aware of the alignment of the valley being flown in, and of those nearby, will help maintain situational awareness.

Discuss using the position of the sun to improve situational awareness and knowledge of orientation. For example, if the sun was in front of the right shoulder entering the valley, and if insignificant time elapses, it should be behind the left shoulder exiting the valley.

Emergencies

Emergency landings, whether forced or precautionary, are more of a challenge when flying below the ridgeline.

The lack of a real horizon is the primary problem.

There are many variables to consider: height available, distance to viable landing sites, existence of viable sites within reach, wind/turbulence/precipitation conditions, and light conditions, to name just a few.

Confined spaces will affect the plan.

The wind will also affect the glide range – avoid sink and use lift if possible. It may be possible to take a calculated gamble on the presence of an anabatic or katabatic wind.

The valley being flown over will probably have a gradient – how steep is it? What will be the elevation of the landing site? Are there any wires?

Be aware of the illusions and mindsets that can be experienced.

Make an early MAYDAY call, possibly on 121.5 MHz, set transponder code to 7700 and activate the ELT.

Look for habitation and head for it.

Before take-off, there should be an appropriate survival kit on board and the pilot should have knowledge of its contents and use. See the *Survival* GAP booklet for more information.

Airmanship

In this lesson the student must be doing more than just thinking ahead, they must anticipate the environment they cannot yet see, in order to ensure they are not left in a situation where reacting quickly is the only option left open to them.

It's important that they learn to recognise threats and develop appropriate strategies to mitigate those threats.

It's much better to have sound decision making than rely on inadequate aeroplane performance to provide escape options.

The student must remain aware of their situation at all times, in particular remaining aware of the changing weather, nearby terrain, other traffic in the area, and their own performance.

It's helpful to make position reports both before and after crossing saddles to assist with traffic awareness.

As with any low flying, more frequent use of SADIE checks is advised.

The minimum descent altitude for this exercise is restated (refer CFI).

Recognition of the 500, 1000, and 1500 feet AGL reference points should be discussed.

Aeroplane management

Revise the poor visibility configuration, considering when it's necessary to adopt, and the effect it has on performance.

Review V_A, V_S, and operating speed range considerations. Review the use of power as necessary to remain safely above stall speed, but in anticipation of potential turbulence, below the maximum manoeuvring speed.

Carburettor heat as required.

Review leaning the mixture for engine considerations, performance, and economy.

Revise control coordination to ensure smooth, balanced, handling to reduce unnecessary stress on the aeroplane, passengers and pilot.

Consider the positioning of the aeroplane in relation to the terrain while taking into account wind direction and speed, so as to mitigate the effects of turbulence.

Human factors

The illusions experienced when flying without a horizon have been discussed earlier, but expand on the other illusions the student may experience. Whiteout and disappearing ridgelines, for example.

Workload, stress, fatigue and effect on performance – employ sound planning techniques, good training and currency to reduce any degrading effect on performance.

Hypoxia and dehydration factors – be knowledgeable and aware of the effects on performance.

Direct the student towards more reading on this subject. There are a number of GAP booklets that deal with flying in mountains, such as *Mountain flying*, *Survival*, the *In, out and around* series, as well as the *Mountain flying* DVD.

Air exercise

Review the previous lesson and the skills developed there.

This lesson should start approaching any terrain. Discuss horizon, wind, gradient and potential lift/sink well in advance of the arrival in any valley.

Identify and interpret wind cues for speed and direction.

Superimposed horizon

Fly a constant altitude while maintaining a constant wingtip distance from terrain to provide the instructor with insight into the student's performance near terrain.

By using outside reference as the primary source, and only confirming performance with instruments, this exercise will help to develop the skill of accurately superimposing the horizon onto varied backgrounds.

This exercise should be flown smoothly and with coordinated control movements. While flying smoothly and maintaining a constant altitude and distance from terrain, encourage the student to develop an awareness of the area around them and their position in it. They should also be gaining an appreciation of inertia when they make turns, be consistently aware of their escape options, be applying the right of way rules, and using an appropriate lookout technique.

Next, fly a constant height above a descending valley floor to give the student an appreciation of gradient and shifting horizon perspective.

Turn around and fly a constant height above a rising valley floor to appreciate the same things.

Operating in a valley

This is ideally carried out in a valley that provides a variety of slopes, valley sides, background terrain, and weather conditions. This may not be practical, so a variety of valleys and conditions should be used.

Turns should be made while level, climbing, and descending.

When approaching the entrance to a valley, or in a narrowing valley and unsure of the radius required; make check turns to evaluate the turn radius of the aeroplane, exit options, and the space available for an escape.

Start with complete 360 degree level turns both left and right, in the cruise configuration, using the full width of the valley. Then the same level turns in the poor visibility configuration.

Note the difference in appropriate aeroplane position when in a narrow valley compared to a large one.

Make steep descending turns into a valley. The student should correctly anticipate the location the aeroplane should roll out, and notice the changing horizon perspective and reduced space available.

The student should be able to make efficient climbing turns, to enable the aeroplane to either climb out of a valley or to position for a saddle crossing using the available lift to assist, and avoiding sudden sun strikes.

If the valley has a vertical face, experience the turning radius through 180 degrees in both the cruise and poor visibility configurations, to appreciate the effects of illusions.

Crossing ridges, saddles, passes, or spurs

Apply a CPL standard to the previously established principles of assessing the appropriate flight path for approach, crossing, and after crossing, that applies the safest compromise of the options and principles involved.

This exercise will be carried out in wind conditions that may exceed 15 knots.

Demonstrate use of parallax to assess height in relation to a saddle.

The student should be able to demonstrate saddle crossings, while taking into account, the approach, the effect of wind, the turbulence, their height, their speed, an efficient crossing, and be able to show you where they would escape to at any point. A safe airspeed must be maintained at all times and the aeroplane flown smoothly. Where compromise may be required, assessment of the best option should be made.

The student should apply sound decision making and be able to discuss the process. Their consideration of suitable escape options in conditions of unexpected sink or turbulence should be of primary concern.

Route finding

While conducting mountain flying training, or during dual cross country training and operating below the ridge line, allow the student to experience their own real disorientation and guide them through strategies for reorientation. If this is not possible, you may need to simulate the exercise.

Emergencies

Take opportunities to simulate forced or precautionary landings whenever the aeroplane is below a ridge line. Emphasise the need to recognise and mitigate any threats.

The student may have difficulty adjusting to a situation where the standard pattern cannot be flown, including a forced landing without power where the only option is straight ahead.

Airborne sequence

Develop local simulated scenarios so you can assess a student's entry into and exit from a valley system, climb into and out of a valley system or crossing from one valley system into another.

When conducting cross country training, consider routes and altitudes that facilitate practical application of principles learned.

Basic mountain flying

Objectives

- To consistently identify a useable horizon and to superimpose it on a variable background.
- To appropriately position an aircraft in a valley and to conduct level, climbing and descending turns.
- To safely approach, cross, and position after crossing ridges, saddles, passes or spurs.
- Experience real or simulated circumstances of disorientation and the strategies for reorienting in place and time.
- To practice emergencies where options may be limited.

Considerations

- Wind indicators for speed and direction

Superimposed horizon

- Horizon is where the sea meets the sky
- Illusions – most dangerous is slowly rising terrain in bottom of valley
- Experience factors affecting contour flying at constant altitude

Operating in a valley

- Check turns
- Select appropriate position in valley
- Use minimum angle of bank
- Poor visibility configuration
- Climbing and descending turns for entry and exit of valleys
- Valley gradients
- Sun and shade

Crossing ridges, saddles, passes or spurs

- Consider all aspects of crossing, effect of wind and terrain, escape options, parallax, saddle types
- Increased wind
- Approach path should be planned well ahead
- Escape options

Route finding

- Good planning and preparation
- Water flow
- Valley alignment
- Sun's position

Emergencies

- No horizon → more difficulties
- Variables:
  - Height
  - Distance to landing site
  - Existence of landing site
  - Wind/turbulence/precipitation
  - Light
- Confined space
- Wind, lift/sink
- Valley gradient
- Illusions and mindsets
- Early MAYDAY
- Habitation
- Survival kit – contents and use

Air exercise

- Identify and interpret wind cues

Superimposed horizon

- Fly constant altitude and constant wingtip distance from terrain for indications of student performance
- Smooth coordinated control movements
- Awareness of: area and environment, inertia while turning, escape options, right of way rules, lookout
- Fly constant height above descending valley floor
- Fly constant height above climbing valley floor

Operating in a valley

- Check turns
- Level, climbing and descending turns
- Cruise configuration, using full width
- Poor visibility configuration, using full width
- Position in the valley dependent on space available
- Steep descending turn into valley
- Climbing turn out of valley or for saddle crossing
- Right of way
- Lookout principles

Crossing ridges, saddles, passes or spurs

- All factors of approach, crossing, after crossing and escape options throughout
- Wind >15 kt
- Saddle crossing, taking all effects into account
- Show sound decision making

Route finding

- Simulate or use actual opportunity to experience/practise

Emergencies

- FLWOP and precautionary landing where no real horizon
- Apply sound decision making
- Adapt standard pattern
- Identify and mitigate threats

Airmanship

- Anticipate environment and recognise threats
- Aeroplane performance
- Situational awareness
- Position reports
- **SADIE**
- Always have escape options

Aeroplane management

- Poor visibility configuration
- Operating speed range between V_S and V_A
- Use of power
- Carburettor heat
- Engine leaning
- Control coordination
- Aeroplane position

Human factors

- Illusions – whiteout, brightout
- Workload, stress, fatigue – effect on performance
- Hypoxia
- Dehydration
- Further reading

Instrument flying

The instrument lessons are to be carried out as dual instruction only and will be dictated by the conditions on the day. For the compass turns and night flying lessons, these will also involve solo practise subsequent to dual instruction. Please refer to your CFI.

Compass use

The magnetic compass is the primary navigation aid for most light aeroplanes.

It's the only instrument in most light aeroplanes that indicates the correct heading. The direction indicator (DI) or directional gyro (DG) is simply gyro-stabilised and can be set to any heading. To be of any value it must be manually aligned with the magnetic compass on a regular basis.

In using the magnetic compass for navigation purposes there are more considerations than just the turning errors.

The magnetic compass displays several errors in its use, most of which the DI eliminates. If, for any reason, the DI becomes unusable, the pilot will need to be able to turn onto and maintain a compass heading.

The cause of compass errors is not as important as how to compensate for those errors in flight. A basic understanding of the causes of compass errors is all that is required.

Objective

To turn accurately onto, and maintain, compass headings, compensating for known errors in the magnetic compass.

Considerations

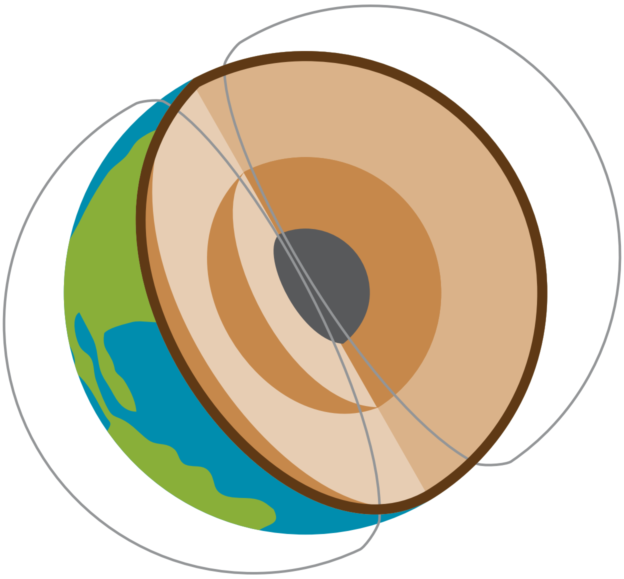
Variation

The earth has a geographical (true) North Pole and a geographical (true) South Pole.

A magnetic field exists around the earth, produced by the equivalent of a very large bar magnet within the earth (see Figure 1). This results in a magnetic North Pole and a magnetic South Pole.

Figure 1

The earth has geographical and magnetic north and south poles



The magnetic poles are not in the same places as the true poles; however, currently they are close, enabling us to use magnets to navigate around the world.

The angular difference between true north and magnetic north at any point on the earth is called variation. This difference is more relevant when navigating because maps are drawn with reference to true north, and the aircraft is navigated by reference to magnetic north. This will be covered during future navigation lessons.

Deviation

When the bar magnet or magnetic compass is acted on by a magnetic field other than the earth's, the magnet deviates. Most metal objects or electrical fields produce a magnetic field that will cause the compass to read incorrectly. This effect is known as deviation. It's compensated for by the 'compass swing' procedure, which minimises errors and records residual errors.

The compass deviation card displays the correction to apply.

Dip

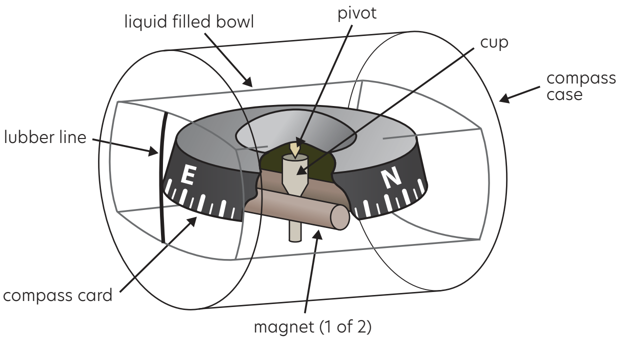
At the magnetic equator, the earth's magnetic field lies parallel with the earth's surface, and a bar magnet would also lie parallel. As the poles are approached, the lines of flux dip down toward the earth's surface, and so does a bar magnet.

Suspending the compass card from a pivot point above the magnet almost eliminates dip.

The pivot arrangement is unstable, so the compass card and magnets are immersed in a fluid that damps out oscillations, and also provides lubrication (see Figure 2).

Figure 2

Magnetic compass



Acceleration errors

The compass always sits at a slight angle to the earth because the magnet is suspended below a pivot point. The centre of gravity of the magnet will not lie directly beneath the pivot point, and when the aeroplane accelerates or decelerates, the centre of gravity lags behind due to inertia and rotates the compass card.

This does **not happen when heading north or south**, and is at a **maximum when heading east or west**.

In practice, the compass will indicate an apparent turn toward the **S**outh when **A**ccelerating and an apparent turn toward the **N**orth when **D**ecelerating. The mnemonic **SAND** is used to remember these effects.

Power changes, in aeroplanes with sufficient power, produce acceleration or deceleration errors, although these errors are most noticeable during attitude changes.

Turning errors

In a balanced turn, the bar magnet stays aligned with the aeroplane and therefore increases its angle to the horizon.

To compensate for this, when turning onto northerly headings the pilot must continue the turn past the indicated heading, and when turning onto southerly headings, stop the turn before the desired compass heading.

The mnemonic **ONUS** is used to remember this (see Figure 3):

- **O**verturn the required heading when turning onto **N**ortherly headings, and
- **U**nderturn the required heading when turning onto **S**outherly headings.

The compass turn is carried out at 'rate one' – this is a turn of 360 degrees in two minutes.

While turning at rate one, the error between the desired heading and the indicated heading on 000 and 180 is approximately 30 degrees. For this correction to work, the turn must be rate one, balanced, level and without pitch changes.

Figure 3

Using the mnemonic ONUS

The turn coordinator will indicate a balanced rate one turn at normal cruise airspeed (it will not indicate the angle of bank).

Airmanship

During taxiing, the compass is checked for correct sense – turning right, numbers increasing, turning left, numbers decreasing. On lining up, the compass heading is compared with the runway heading and can be expected to be within approximately 10 degrees.

The turn coordinator or indicator should also be checked for serviceability. Most turn coordinators are electrically driven and display a red warning flag when power is not being supplied. During turns while taxiing, the turn coordinator should display a rate of turn in the correct sense.

Emphasise that lookout is the most important part of any turn and must be maintained, before, during and after the turn.

Aeroplane management

The compass system should be checked for serviceability before flight.

If the fluid in the compass has bubbles or leaks out, the compass will become less stable. Check for cracks or fluid leaks as well as fluid discoloration.

Ensure the deviation card is valid by checking that the expiry date has not passed. Although the corrections given for various headings are generally considered insignificant for practical flight use, the deviation card is the only indication that the compass swing has been done, and that any errors found were not excessive.

The introduction of any metal object or electrical field, such as headphones, GPS, or calculators, into the cockpit will affect the accuracy of the magnetic compass. Keep these items as far away from the compass as possible.

Except for Technically Enhanced Aircraft (TEA), often referred to as 'Glass Cockpit' aircraft, vacuum pump failure is the most likely cause of DI failure, so the suction gauge should be checked during engine run-up (4.5 to 5.2 inches Hg).

Human factors

To minimise disorientation, a three-dimensional picture, including the cardinal points of the compass, should be developed and retained in the pilot's memory.

In-flight mental calculations should be kept to a minimum.

The pilot should not have access to unreliable information that could be used. It's recommended that unreliable information, ie, instruments that have failed, are covered.

Air exercise

Draw the compass rose in plan view, and divide it into two halves with the cardinal headings labelled. Turning errors are zero on east and west, and a maximum of 30 degrees on north and south – label these.

Intermediate headings and their associated error are now labelled. In addition, the top half of the rose is labelled **ON** and the bottom half **US**.

This information will need to be memorised by the student and should be included in the lesson handout.

The procedure for turning onto a specific compass heading is broken down into several steps.

Making the turn

Which way to turn?

The turn is always made in the shortest direction. For example, a turn from east to north requires a turn to the left.

Given the presentation of the compass rose, this is quite a simple deduction. However, the aeroplane's magnetic compass does not present the information in this format. Therefore, some method of deciding the shortest arc to turn through must be provided to the student.

It's assumed that the DI has failed, or is unreliable, so should be removed from the pilot's scan. As the simple plan view of the compass rose is easy to interpret and is what the student has memorised, some other instrument, preferably orientated with north always at the top, is substituted for the DI.

There are several methods available.

First – and best – the back of the cover used to hide the DI could have a drawing printed on it that shows the error or correction associated with each cardinal and intermediate heading (see Figure 4).

Second, if the aeroplane is fitted with an ADF or VOR, the remote indicators associated with these (ADF card or CDI) may be used as a reference.

The first step in visualising which way to turn, is to read the compass. This heading is plotted on the substitute.

Then the desired heading is plotted in the same manner and the shortest arc chosen. For example, to turn from 040 to 270 – which way would you turn?

Figure 4

Aircraft compass (left), compass rose in plan view (right)

This method avoids mathematical calculations. However, when the heading required is near the reciprocal of the current heading, it may result in a turn the wrong way. In practical terms, if the desired heading is at or close to the reciprocal, a turn in the wrong direction will have little impact.

Will an overturn or underturn be required (ONUS)?

Without access to the error/correction drawing, this would require the student to know, for example, that 120 is a southerly heading.

In practice this can be deduced from the methods above.

What correction will need to be applied?

Unless a drawing on the back of the DI cover is supplied, the student needs to memorise the correction factors.

What will the compass read when the roll out is started?

There are three methods to determine this.

First, the heading on which to start the roll out can be calculated mentally by adding or subtracting the correction factor. However, this not only requires an appreciation of whether to underturn or overturn but also depends on which way the turn is being made. For example, a turn onto north from 090 requires an overturn of 30 degrees to a roll out heading of 330 (subtract 30), while a turn onto north from 270 will result in a required roll out heading of 030 (add 30).

The second method relies on the emphasis placed on the meaning of overturn and underturn.

Overturn means go past the desired heading, while underturn means to stop short of it. In the case of overturn, therefore, the turn is continued until the desired heading is seen under the lubber line and the turn continued for the appropriate correction. In the case of underturn, when the desired heading is seen approaching the lubber line the roll out is started before the desired heading is reached by the appropriate correction.

A third method, more appropriate to CPL training than basic training, of estimating when to roll out relies on timing. Since a rate one turn results in a turn of 360 degrees in two minutes, the rate of turn is calculated as three degrees per second. Knowing the arc to be turned through, the amount of time required at rate one can be calculated and the turn timed using the clock.

When the calculated heading to roll out on is seen under the lubber line, roll out smoothly. Anticipation of the heading by 3 degrees, given the roll out takes about one second, should allow for an accurate compass turn. Immediately choose a reference point on the horizon and fly on the reference point, wings level, and balanced. Give the compass time to settle – don't chase the heading.

When reading the compass, ensure that the wings are level and that the aeroplane is in steady balanced flight, as these are the only conditions under which the compass will read accurately.

Making the correction

Often the required heading will not have been achieved exactly, so minor corrections will need to be made using the 3 degrees per second rate one turn principle.

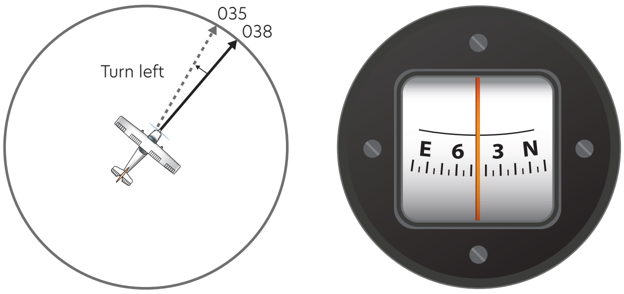
Which way to turn?

One method is to reverse the sense. For example, if the required heading is left of the lubber line, turn right. This sounds simple but many students find this method confusing.

Another is for the student to visualise themselves in the centre of the compass rose and looking down the compass heading over the nose of the aeroplane. If the compass reads, for example, 038 and the desired heading is 035, the desired heading is left of the present heading (see Figure 5). Do not look at the compass.

Figure 5

Visualise being in the centre of the compass



Yet another method is to employ the serviceability check carried out during taxiing, turning right, numbers increase, turning left, numbers decrease. Therefore, a turn from 038 to 035 requires a decrease or left turn. This method has the advantage that nothing new needs to be learned. But, this method works only for small heading changes, or corrections, and cannot be applied to the initial turn direction calculation. For example, turning from 030 to 300, the shortest arc is left but numbers increase to the right.

Where more than one method is available to explain a procedure or calculation, it's recommended that you choose only one explanation to deliver to the student. If the student cannot understand that explanation, rather than just repeat it a little louder, you can then use another explanation. Once the student has grasped the principles, other methods of arriving at the same conclusion can be introduced to reinforce learning.

When to roll out?

There are two methods available to determine this.

The first, used primarily in instrument flight, relies on timing the turn at three degrees per second and is reasonably easy to do for small corrections: 5 to 10 degrees = approximately 2 to 3 seconds. Saying "one thousand" equates to about one second, therefore, begin counting when the rate one turn is started, rather than timing on the clock.

The second, used in a practical VFR sense, is to estimate the required heading change and select a new reference point on the horizon, and complete a turn onto the new reference.

In either case, roll out smoothly, maintain balanced level flight on the reference point, and allow the compass time to settle.

Airborne sequence

On the ground

During the preflight inspection pay particular attention to the serviceability checks of the compass and the validity of the deviation card.

Look at the compass heading before turning the master switch on and the watch the effect of starting the engine.

During the taxiing instrument checks, note that the turn coordinator gives a rate of turn, not the angle of bank, and that the DI can be set to read any heading desired, regardless of the aeroplane's actual heading.

The exercise

The airborne sequence starts with a demonstration of acceleration and deceleration errors. Maintaining a heading of 090 or 270 by reference to the DI or reference point, accelerate the aeroplane by smoothly pitching the nose down; note the apparent turn toward the south. This exercise is repeated to demonstrate deceleration effects by smoothly pitching the nose up; note the apparent turn toward the north.

Smoothly increasing and decreasing the throttle also produces this effect in all but low powered aircraft. Remember the engine handling principle of 3 seconds to open or close the throttle.

When this exercise is repeated on headings of 000 or 180 no apparent turn will occur, although the compass may be seen to dip. Ensure the aeroplane is kept straight by reference to the DI or reference point.

The demonstration of acceleration errors is concluded with a reminder that when accelerating, decelerating or pitching, keep straight on the reference point. In addition, to compensate for turning errors accurately, it will be necessary to avoid pitch changes during the rate one turn.

Turning errors are demonstrated by completing a 360 degree rate one turn and noting the difference between the compass heading and the DI on cardinal and intermediate headings. Point out that these errors or corrections are only true in a level, balanced, rate one turn. Start on a compass heading of 090 or 270 (with the DI aligned) and have the student read out the compass heading when you read out a DI heading. In a turn to the right you read out 030 (DI), the student should read out about 010 compass, a 20-degree difference.

Once the errors have been observed, a DI failure is simulated. Using the recommended steps, compass turns onto cardinal headings are practised.

Beware of lookout degradation during calculations.

Commonly, when the aeroplane is rolled wings level, there is a tendency by the student to fixate on the compass rather than maintain level flight on a distant reference point. This tendency can be overcome by covering the compass with your hand just as the student starts the roll out and insisting that they choose and fly a reference point. Allow the compass adequate time to settle, ensure the aeroplane is in balanced flight, and then remove your hand to read the compass.

Depending on which method is used for minor corrections, cover the compass again and calculate which way to turn. Calculate the time required or choose a new reference, turn and regain balanced level flight. Allow the compass to settle and remove your hand to read the compass.

When the compass reads the correct heading, emphasise the reference point to maintain heading. Do not allow the student to fixate on the compass – instruments are used to confirm performance, not set it.

After flight

The student will need to practise these solo.

Compass use

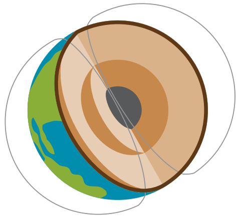
Objective

To turn accurately onto and maintain compass headings, compensating for known errors in the magnetic compass.

Considerations

Variation

- Difference between true North and magnetic North
- Bar magnet will align itself with lines of flux

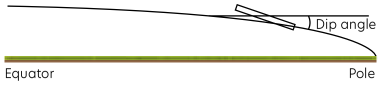


Deviation

- Aircraft magnet acted on by things other than the lines of flux, ie, metal objects, aircraft, etc
- Compensated for by a compass swing – done by an engineer

Dip

- At magnetic equator flux lines are parallel with surface
- As they approach the poles they dip down towards the earth's surface
- A bar magnet tries to align with the lines of flux dip towards the earth's surface
- To compensate, the bar magnet is set on a pivot, but some residual dip remains
- The pivot arrangement is fairly unstable, so compass card and magnets are immersed in fluid that damps out oscillations – also providing lubrication



Acceleration errors

SAND

- Apparent turn **S**outh when **A**ccelerating, apparent turn **N**orth when **D**ecelerating

Turning errors

ONUS

- To compensate must **O**verturn on **N**orth and **U**nderturn on **S**outh
- Use rate one turn, maximum error on N or S = 30°

Air exercise

- Demonstration of acceleration and deceleration errors
- Demonstration of turning errors

Making a turn

- Check present heading against desired heading – use shortest arc
- Decide on amount of overturn or underturn – ONUS
- Lookout and roll in using rate one turn – balance
- Anticipate roll out
- Select reference point
- Level wings – hold for compass to settle
- Check heading and make correction if required (3° per second)

Airmanship

- Compass checked during taxi for correct sense and runway heading
- Turn coordinator checked for serviceability
- Lookout

Aeroplane management

- Compass system checked for serviceability before flight
- Deviation card is valid
- Keep metal items as far away from the compass as possible
- Suction gauge should be checked during engine run-up (4.5–5.2 inches)

Human factors

- Helpful to have a 3D picture of compass in your head
- In-flight mental calculations should be kept to a minimum
- Cover failed instruments to avoid confusion

Instrument flying introduction

Flight in cloud can be dangerous because when we are deprived of visual references, the body's other senses may provide conflicting information to the brain. Without the benefit of visual references to resolve these conflicts, loss of aeroplane control can occur very quickly, usually within a minute.

However, instrument flying has a practical application to visual flying when the normal cues are missing or misleading. For example: low flying, mountain flying, night flying, or flying over water with a poor horizon.

Instrument flight is challenging because of the need to interpret and anticipate the instrument readings while recognising or ignoring the conflicting messages sent to the brain by our earth-bound orientated senses.

Inadvertent flight into cloud can be avoided by maintaining a high level of situational awareness. However, a five-hour course of instrument flying is included in the requirements for PPL issue to give the pilot and passengers some chance of survival should the event occur.

Objectives

To experience the sensory illusions that occur when deprived of visual references.

To maintain straight and level flight by sole reference to the aeroplane's instruments.

To climb, descend, and turn by sole reference to the aeroplane's instruments.

Considerations

Describe the method of simulation that you will use, for example, hood or glasses.

Discuss the direct and indirect information that each of the flight and engine instruments give, as well as their power source.

The formula Power + Attitude = Performance remains unchanged for instrument flight. There are two types of instruments – control instruments and performance instruments.

Control instruments

Attitude indicator or artificial horizon

The attitude indicator (AI) or artificial horizon (AH) is the master instrument, because it presents pitch and bank attitude information directly (in miniature) against an artificial horizon.

Miniaturisation of the outside world means that small movements indicated on the attitude indicator represent quite noticeable changes in pitch and bank. Therefore, it's common to speak of pitch attitude changes in relation to the width of the wing bars representing the aeroplane within the AI. For example, the straight and level attitude is half a wing bar width above the horizon.

Indirectly, the attitude indicator is a guide to airspeed (nose low – high or increasing airspeed, nose high – low or decreasing airspeed).

Unless in a Technically Enhanced Aircraft, the attitude indicator is most commonly driven by an engine-driven vacuum pump.

Tachometer

The tachometer directly indicates the engine RPM and indirectly the engine power output. In addition, RPM may indirectly indicate pitch attitude (RPM increasing – nose low, RPM decreasing – nose high).

The tachometer is commonly driven from the engine by a mechanical cable.

Performance instruments

Airspeed indicator

This gives the aeroplane's speed directly and, indirectly, pitch attitude (airspeed increasing – nose low, airspeed decreasing – nose high). Its source of information is the pitot-static system.

Altimeter

The altimeter directly indicates the height of the aeroplane above a datum, usually sea level. Indirectly, it indicates pitch attitude (altitude decreasing – nose low, altitude increasing – nose high). Its source of information is the static system.

Heading indicator

The heading indicator is known as the direction indicator (DI), directional gyro (DG), or horizontal situation indicator (HSI). The DI directly indicates the aeroplane's heading when aligned with the magnetic compass. Indirectly, it can indicate bank. Heading indicators are commonly driven by the engine-driven vacuum pump.

Turn coordinator

The turn coordinator (TC), or turn indicator, directly indicates the rate of change of direction. Indirectly, it can indicate limited angles of bank (provided balance is maintained), commonly up to about 35 degrees. Any further increase in bank angle will not be indicated by the turn coordinator. Turn coordinators are normally electrically driven.

Balance indicator

The balance indicator is commonly incorporated within the turn coordinator and directly indicates balance. Indirectly, it indicates yaw if the wings are level, or bank. Its power source is gravity, or the resultant forces of in-flight accelerations (CPF, CFF).

Vertical speed indicator

The vertical speed indicator (VSI) directly indicates the rate of change of altitude in feet per minute. Indirectly, it indicates pitch attitude, and it's most useful when used as a trend indicator, as it will indicate a tendency to change altitude before the altimeter registers any change. Its information source is the static system.

Instrument layout

The four instruments, attitude indicator, airspeed indicator, altimeter, and heading indicator, are arranged on the instrument panel in a basic 'T' shape.

The addition of the turn coordinator/balance indicator, and the vertical speed indicator make up the full instrument flying panel.

While not part of the six instruments referred to, the RPM gauge is incorporated into scan techniques as appropriate.

Instrument lag

All instruments suffer from lag, some to a greater extent than others. All instruments can be considered to be responsive enough for light aeroplane use. The VSI, however, suffers from significant lag, and must be cross-referenced with other instruments to check its indications.

Airmanship

The importance of checking instruments while taxiing, and in-flight SADIE checks are revised.

During visual flight training the requirement to counteract inertia (change – check – hold – adjust – trim) will have become automatic as a result of cues detected by peripheral vision. These cues will no longer be available and the necessity to consciously counteract inertia through this process when changing attitude will need to be emphasised during early instrument lessons.

The student should be prompting the lookout, by calling "clear left?" if a left turn is to be conducted and should receive a "clear left" response from the instructor.

Aeroplane management

The aeroplane's vacuum and pitot-static systems should be described.

The method of setting the attitude indicator's aeroplane symbol before flight, and the desirability of not altering it in flight, are explained.

Human factors

Humans use three sensing systems to gather and transmit information to the brain in order to remain orientated. These are the balance organs within the vestibular system of the inner ear, the muscular pressure sensors of the nervous system, and vision – the most powerful system of the three.

The balance organs of the vestibular system sense angular acceleration or change of direction in three different planes by the detection of fluid movement in the semicircular canals. In addition, the otolith organs sense linear acceleration as well as head or body tilt, through the movement of a jelly-like mass over sensitive hairs.

This system is limited by the inability to detect change when the direction or the angular acceleration is constant or very slow. It can also misrepresent acceleration as a nose pitch up, because of the effect of inertia.

The muscular pressure sensors of the nervous system are affected by gravity and allow us to detect, for example, whether we are standing or sitting when our eyes are closed.

Crucially, this system cannot differentiate between the various causes of increased G – for example, as the result of pulling out of a dive or of entering a steep turn.

The visual system is the most powerful of the orientation systems and normally resolves any ambiguous or conflicting information received by the brain. For example, this is a steep turn not a pull-out of a dive.

In instrument flight conditions, the visual references used to resolve ambiguous or conflicting orientation information are not available. Until considerable practice has been carried out to replace the normal visual cues with instrument readings, orientation conflicts may occur, causing various illusions. For example, the 'leans'.

Because the limitations of the human orientation system are considerable, and instrument failure is rare, **trust the instruments**.

Air exercise

The air exercise starts with a demonstration of the limitations of the vestibular and muscular systems.

Selective radial scan

Selective radial scanning recognises that the attitude indicator is the master instrument. Therefore this scan employs an instrument scanning pattern that radiates out from, and always returns to, the attitude indicator.

The relative importance of the performance instruments varies, and therefore the scan rate varies, with the manoeuvre being executed. Describe this in relation to maintaining straight and level, as well as achieving straight and level from the climb and descent.

Airborne sequence

The exercise

It's important to demonstrate the limitations of the body's physiological orientation systems carefully. The instructions below should be followed exactly so that the student experiences the false sensations of turning and pitching. An unconvincing demonstration may lead the student to believe they are immune to false indications. There are many demonstrations that show the susceptibility of the human senses to disorientation. It should only be necessary to show a few of them.

The false sensation of turning

In straight and level flight, ask the student to close their eyes and lower their head, remind them to resist any temptation to look out, if they do they will not feel what is normally sensed during instrument flight.

Lower the right wing very gently and then positively roll the wings level while raising the nose attitude without changing power. At this stage ask the student what attitude the aeroplane is in. Their balance and postural sensations will normally lead them to conclude that the aeroplane has entered a turn to the left.

The false sensation of climbing

In straight and level flight, ask the student to close their eyes and lower their head. Enter a medium turn to the left using a positive entry, then very gently change to a turn to the right while applying consistent backpressure to the control column. Ask the student to tell you what attitude they think the aeroplane is in. The sensation they have felt will be that the aeroplane is in a climbing left turn.

Once the student has seen that the sensation received from the senses of balance and posture can be misleading, they'll have a better appreciation of the need to be able to fly by instrument reference should they inadvertently enter cloud or any other condition where outside visual references are minimal or completely absent.

It's not necessary to handle the aeroplane violently or adopt extremes of attitude to achieve the effects of disorientation.

During transitions from the climb or descent to straight and level, it will be necessary to slow the students actions down to consciously follow the 'change – check – hold – adjust – trim' sequence.

Student practice

Reinforce what the student should have observed with the instruments on previous VFR flights to verify that small movements on the AI result in noticeable changes in pitch and bank.

Now have the student put on the hood or glasses, get comfortable and ensure they cannot see out. Then they should practise the selective radial scan, first in straight and level, and then moving on to climbs, descents and turns, emphasising the 'change – check – hold – adjust – trim' sequence.

On the ground

The handout for this lesson should include the limitations of the human balance system, as well as a range of articles on incidents and accidents resulting from attempting continued VFR flight into deteriorating weather.

Instrument flying introduction

Objectives

- To experience the sensory illusions that occur when deprived of visual references.
- To maintain straight and level flight by sole reference to the aeroplane's instruments.

Considerations

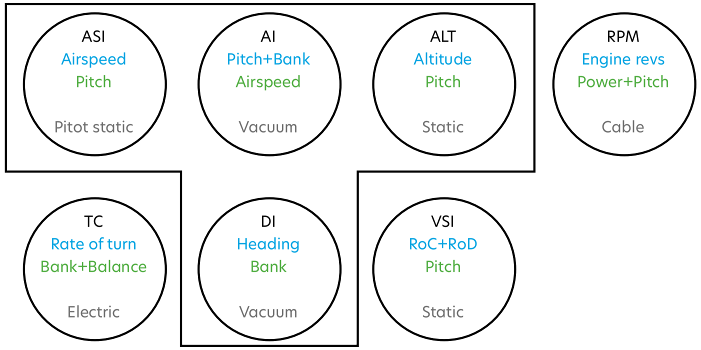
- Power + Attitude = Performance

Control instruments

- Attitude indicator
- Tachometer

Performance instruments

- Airspeed indicator
- Altimeter
- Directional indicator
- Turn coordinator
- Balance indicator
- Vertical speed indicator



Instrument layout

- Basic T plus TC, VSI and RPM

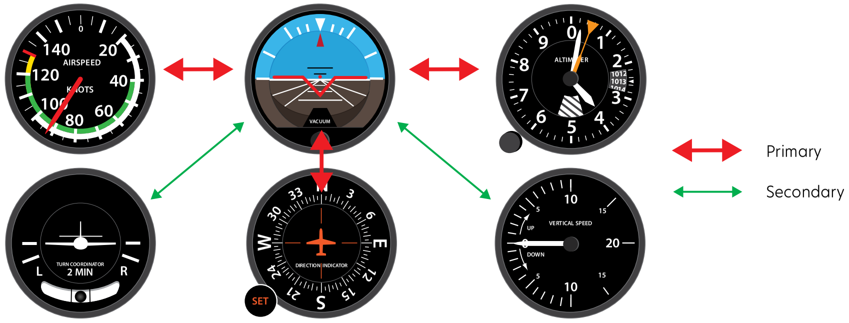
Instrument lag

- All instruments have lag (delay in indicating correct information)
- Only VSI lag is significant, must be checked against other information

Air exercise

- Demonstration of limitations of vestibular and muscular system

Selective radial scan



Maintain straight and level

- Set attitude, check altitude, heading and airspeed being maintained
- Check in balance and VSI showing level

Attain straight and level from a climb or descent

- APT and PAT

Turns

- All turns at rate one

Airmanship

- Instrument check while taxiing
- Can't use peripheral vision
- Need to consciously counteract inertia
- Change – check – hold – adjust – trim
- Lookout "clear left"....

Aeroplane management

- Pitot static system operation
- Set AI symbol before flight, don't change

Human factors

Balance organs

- Sense angular acceleration and change of direction in 3 planes, and body tilt
- Can't detect change when it's very slow or constant

Muscular pressure sensors

- Affected by gravity
- Know if standing or sitting with eyes closed
- Can't distinguish between causes of increased G

Vision

- Most powerful system
- Usually resolves ambiguous information from other senses
- But in IF conditions visual references not available
- Leans
- Trust the instruments

Limited panel

When any one or more of the basic six flight instruments fails, or is unserviceable, the instrument panel is limited.

Failure of the master instrument, the Attitude Indicator (AI), is the most serious and, therefore, the most commonly simulated. However, failure of the other instruments does occur and it's important to recognise the failure early.

Limited-panel instrument flight at the PPL level requires only the ability to fly straight and level and carry out level rate one turns onto compass headings (sufficient to reverse course and fly out of cloud). Additional briefings will be required to adequately cover the requirements of limited-panel instrument flight for CPL students.

This exercise simulates the failure of one or more flight instruments before or after inadvertently entering cloud. In this situation, indirect readings of the other flight instruments are used to fill in the gaps as a result of losing the direct information from the failed instruments.

Limited-panel instrument flight still employs the selective radial scan technique that recognises the changing importance of various instruments with the phase of flight.

In a Technically Enhanced Aircraft, should the glass cockpit instrument malfunction, the 'redundancy' instruments are used as below for limited panel flying.

Objectives

To maintain straight and level flight by sole reference to a limited flight instrument panel.

To carry out rate one level turns onto compass headings.

Considerations

Various power or information source failures, and their effects on the flight instruments, are discussed, from the least serious to the most serious.

Although the tachometer is not a flight instrument, its possible failure should be briefly discussed. RPM can be estimated from sound and, since only the gauge is unserviceable, power is still available to be used as required.

Turn coordinator (or turn indicator)

Turn coordinators are normally electrically driven. If power is not being supplied to the turn coordinator, a warning flag is displayed. Its failure would mean that the rate of turn would have to be estimated using angle of bank (about 15 degrees for rate one, up to 100 knots). The balance indicator is unaffected.

The turn coordinator is checked for serviceability during taxiing and the electrical system during SADIE checks.

Vertical speed indicator and altimeter

Both VSI and altimeter rely directly on outside air pressure sensed at the static vent. If the static vent becomes blocked, neither the VSI nor the altimeter will indicate correctly.

Failure of the VSI and altimeter would require use of the control instruments (AI and tachometer) to achieve the desired performance. For example, an attitude for 70 knots plus power setting of about 1500 RPM, equals a rate of descent of about 500 feet per minute.

The static vent is inspected for blockages during the preflight inspection.

Airspeed indicator

The airspeed indicator's source of power is a combination of the static and pitot system. If the static vent is blocked, airspeed indications will decrease in the climb and increase in the descent. If the pitot system is blocked (most commonly by ice), airspeed indications will decrease in the descent and increase in the climb or, depending on the type of pitot-static system, airspeed indications may simply reduce to zero in level flight.

Failure of the ASI requires use of the control instruments (AI and tachometer) to achieve the desired performance.

The pitot tube is inspected for blockages during the preflight inspection.

Heading indicator

Heading indicators are gyro-stabilised and are commonly driven by an engine-driven vacuum pump. If the vacuum pump fails, the gyro will gradually run down, losing rigidity, and the DI will become unusable.

Failure of the DI requires direct use of the magnetic compass for heading information.

The DI and vacuum system are checked for serviceability before flight during the taxi and the engine run-up, and in-flight with SADIE checks.

Remember that the DI will need to be regularly aligned with the compass, as precession will cause it to indicate the wrong heading.

Attitude indicator

The attitude indicator is most commonly driven by an engine-driven vacuum pump.

Failure of the AI will require use of the indirect information available from the performance instruments to establish the aeroplane's attitude.

AI serviceability is checked during taxiing and in flight with SADIE checks.

Airmanship

Revise the importance of checking instruments while taxiing, and in-flight SADIE checks.

Aeroplane management

Revise knowledge of the aeroplane's systems in the event of a malfunction.

The turn coordinator and electrical system are protected by circuit breakers (CB). Electrical failure may affect other instruments, for example, fuel gauges.

The static system is commonly backed up by an alternate static source, the location and operation of this should be described.

The pitot head is commonly heated to prevent ice build up.

The serviceability of the vacuum system is confirmed by regular reference to the vacuum gauge.

Using the SADIE checks will help to ensure the DI is regularly aligned with the compass.

Human factors

Developing a systematic instrument scan to maintain situational awareness is critical.

Because the limitations of the human orientation system are considerable, and instrument failure is rare, **trust the instruments**.

The pilot should not have access to unreliable information that could be used in any way. It's recommended that unreliable information from instruments is covered.

Air exercise

For this exercise, a failure of the vacuum system is simulated – AI and DI unserviceable – and the information available from each instrument to maintain control in each spatial plane is revised.

Pitch

Pitch is determined from airspeed, altimeter, vertical speed indicator and RPM (noise).

Bank

Bank is determined from the turn coordinator when balanced (ball), and compass.

Yaw

Yaw is determined from balance (ball).

The selective radial scan (SRS) technique is described in relation to maintaining straight and level and completing rate one turns onto compass headings without the master instrument.

For straight and level, the altimeter and turn coordinator are incorporated in the primary scan with VSI and compass included in the secondary scan. Airspeed requires little attention since the Attitude + Power combination will provide the desired performance.

For level rate one turns onto compass headings, the altimeter and turn coordinator remain in the primary scan, with the importance of the compass gradually increasing as the required roll out heading is approached. Once again, airspeed requires less attention.

Airborne sequence

The exercise

Start from straight and level on full panel.

A vacuum failure is simulated and therefore the AI and DI are unserviceable. These instruments are capable of providing unreliable information that could be used, so they are removed from the scan by fitting them with instrument covers.

Straight and level is maintained on limited panel and rate one turns practised, eventually onto compass headings.

All instrument flight requires considerable concentration, therefore, do not keep the student at the exercise for long periods – little and often is best.

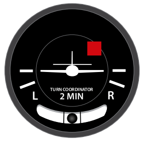
Limited panel

Objectives

- To maintain straight and level flight by sole reference to a limited flight instrument panel.
- To carry out rate one level turns onto compass headings.

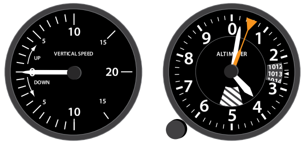
Considerations

Turn coordinator



- Electrically driven
- Failure shown by warning flag
- Estimate angle of bank from AI – 15°
- Balance indicator okay
- Checked during taxi and SADIE checks

VSI and altimeter



- Rely on static pressure
- If fails need to use AI and RPM
- Inspect static vent during preflight

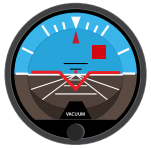
Airspeed indicator

- Requires pitot and static pressure
- Most common blockage by ice over pitot head
- Will indicate wrong airspeed, or zero
- If fails need to use AI and RPM
- Inspect pitot head and static vents during preflight

Heading indicator

- DI, DG, HSI
- Gyro stabilized, powered by engine-driven vacuum pump
- If fails will slowly run down, card will spin
- If fails will need to use magnetic compass
- Checked during taxi and SADIE checks

Attitude indicator



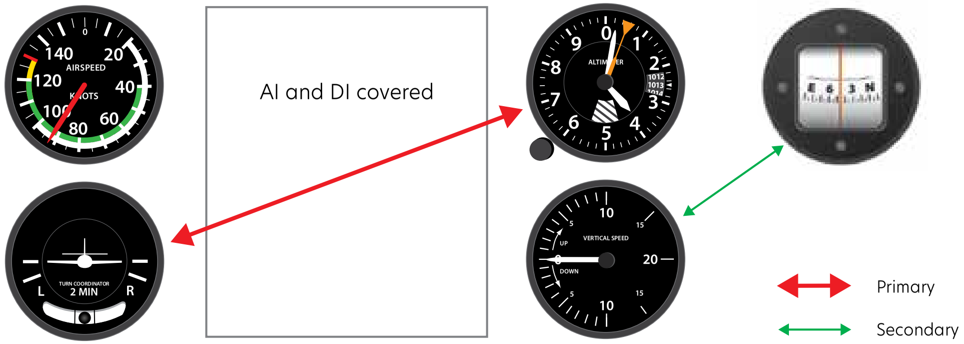
- AH
- Driven by engine-driven pump
- May have failure flag
- If fails will have to use indirect information from performance instruments
- Checked during taxi and SADIE checks

Air exercise

- Simulate vacuum system failure
- AI and DI unserviceable

Pitch	ASI, ALT, VSI, RPM
Bank	TC, Compass
Yaw	Balance

Selective radial scan



- Airspeed will require only a small amount of attention so long as attitude and power are set correctly
- During turns the compass' importance will increase as approach heading

Airmanship

- Instrument check during taxi very important

Aeroplane management

- Electrical system failure may affect other instruments
- Static system often has backup system
- Pitot head heated
- Vacuum gauge checked regularly
- Regularly checking DI is aligned to compass

Human factors

- Develop systematic instrument scan
- Trust the instruments
- Cover failed instruments

Unusual attitudes

The recovery from unusual attitudes is divided into full and limited-panel recoveries. Full-panel recoveries are a requirement of the PPL syllabus, and limited-panel recoveries a CPL requirement.

During full-panel recoveries the AI remains the master instrument. During limited-panel recoveries the indirect information of the performance instruments must be used to assess the aeroplane's attitude and achieve recovery to straight and level flight.

The briefing deals with the recovery of the aeroplane to straight and level once an unusual attitude has been identified.

Basically there are two types of unusual attitude, nose-high or nose-low. The most dangerous of the nose-low attitudes is the spiral dive, because it's difficult to identify.

The spiral dive produces positive G, which feels like a dive pull-out when, in fact, the aeroplane is being pulled tighter into the spiral dive.

Unusual attitudes may come about as a result of disorientation, turbulence (which may be quite pronounced in cloud), or a distraction that breaks down the instrument scan.

Inadvertent flight into cloud, full or limited-panel, can be a very stressful experience. In addition, the effects of stress will affect performance and may result in fixation on one instrument, or on a minor aspect of performance or problem.

Avoid the situation entirely.

Objective

To recognise and recover to straight and level from a nose-high or nose-low unusual attitude.

Considerations

A distraction, fixation, or high workload may cause an interruption to the scan. Disorientation may occur as a result of the 'leans' while night flying or in poor visibility.

The first step in recognising an unusual attitude, is to maintain faith in the instrument indications. This can be difficult when your body senses are screaming at you that the instruments must be wrong.

The unusual attitude recovery is always carried out to regain straight and level. Then a gradual return to the reference altitude and heading is made. No attempt to return directly to the reference should be made, as this may increase disorientation or lead to another unusual attitude.

Recovery from unusual attitudes uses the same 'change – check – hold – adjust – trim' sequence as all flight. However, the initial movements are more pronounced, and trim should not be required.

To regain straight and level, the position of the horizon must be identified. There are several methods of achieving this (refer CFI).

The limited-panel method recommended here is to use the airspeed or the altimeter.

The first action is to check the airspeed, ie, stop it increasing or decreasing, while adjusting power to compensate and rolling wings level.

If airspeed is increasing apply backpressure and reduce power to fix the airspeed at a value. As the airspeed indicator needle stops moving, the aeroplane is in the level attitude, so now using the stationary altimeter needle, hold that altitude as wings are rolled level and a normal straight and level configuration is regained.

If the airspeed is decreasing, apply forward pressure and increase power to fix the airspeed at a value. As the airspeed indicator needle stops moving, the aeroplane is in a level attitude, so now using the stationary altimeter needle, hold that altitude as wings are rolled level and a normal straight and level configuration is regained.

Airmanship

Ensure adequate height for recovery.

Revise systematic instrument scanning to maintain situational awareness.

Revise limiting speeds (V_A, V_{NO}, V_{NE}) and RPM limit.

Aeroplane management

Smooth but positive throttle movements are required when recovering from unusual attitudes.

Human factors

The limitations of the human orientation system are considerable, and instrument failure is rare. If disorientation occurs, **trust the instruments**.

Air exercise

The air exercise covers the recognition and recovery from the nose-high, nose-low, and spiral-dive unusual attitudes.

Nose-high

Recognition

Low or decreasing airspeed, increasing altitude, increasing rate of climb, and decreasing engine RPM.

Recovery

Apply full power and simultaneously level the wings (check balance), push forward on the control column until the airspeed/altimeter stops, check, and hold. When normal cruise airspeed has been regained, reduce power to cruise setting and adjust (trim if required).

Nose-low

Recognition

High or increasing airspeed, decreasing altitude, increasing rate of descent, and increasing RPM.

Recovery

Reduce power (how much depends on the rate of airspeed increase) and simultaneously level the wings (check balance). Ease out of the dive, and check airspeed. When the altimeter stops, check, set cruise power to regain cruise airspeed, hold and adjust (trim if required).

Spiral-dive

Recognition

High or increasing airspeed, decreasing altitude, high angle of bank (usually turn coordinator on its stops), high rate of descent, high or increasing G-loads, and increasing RPM.

Recovery

Close the throttle and simultaneously level the wings (check balance), ease out of the dive, and check airspeed. When the altimeter stops, check, set cruise power to regain cruise airspeed, hold and adjust (trim if required). Remember smooth control movements above V_A.

Once straight and level flight has been regained, return to the original references (heading and altitude).

Airborne sequence

The exercise

Have the student close their eyes and place the aeroplane in gentle unusual attitudes to start with, gradually working your way up. This is best spread across a number of lessons, as too many unusual attitudes in one lesson is counter-productive.

Ensure a safe altitude, and avoid extreme attitudes.

Unusual attitudes

Objective

To recognise, and recover to straight and level from a nose-high or nose-low unusual attitude.

Considerations

- Unusual attitude can be entered due high workload, fixation, leans
- Trust the instruments
- Recover to straight and level first
- Then regain altitude and heading
- Change - check - hold - adjust - trim
- Must identify the position of the horizon

Limited panel

1. Check airspeed-stop further increase or decrease
2. Adjust power to compensate
3. Roll wings level

Change If altitude ↑ - ↓ backpressure (push)
If altitude ↓ - ↑ backpressure (pull)
Until 100s pointer stops moving

Check

Hold

Adjust

Trim (but you shouldn't need to)

Air exercise

- Smooth control movements whenever speed above V_A

Attitude	Recognition	Recovery
Nose high	• Low or ↓ airspeed • ↑ altitude • ↑ rate of climb • ↓ engine RPM	• Full power and level wings • Push forward on c/c until airspeed/altimeter stops • Check • Hold • At normal cruise speed reduce power • Adjust • Trim
Nose low	• High or ↑ airspeed • ↓ altitude • ↑ rate of descent • ↑ engine RPM	• ↓ power and level wings • Ease out of dive, check airspeed • When altimeter stops • Check • Set cruise power • Hold • Adjust • Trim
Spiral dive	• High or ↑ airspeed • ↓ altitude • High angle of bank • High rate of descent • High or ↑ G-loads • ↑ engine RPM	• Close throttle and level wings • Ease out of dive, check airspeed • When altimeter stops • Check • Set cruise power • Hold • Adjust • Trim

- When straight and level regained, return to original reference altitude and heading

Airmanship

- Enough height for recovery
- SRS - A/S, Alt, then the rest
- Limiting speeds - V_A, V_{NO}, V_{NE}, and RPM limit

Aeroplane management

- Smooth positive control movements

Human factors

- Human orientation system has limitations
- Instrument failure rare
- Trust the instruments

Night flying

Flying VFR at night is inherently more risky than flying VFR during the day. These risks and threats can, and must, be managed carefully with good preparation and instrument flight currency.

A student's night flying ability will not be assessed by an examiner, so it's important that the instructor uses the night flying instructional time to ensure the student is aware of the issues and is competent at night flying.

Objective

To operate the aircraft safely both on the ground and in the air at night.

Considerations

Night is defined as the time between the end of evening civil twilight and the beginning of morning civil twilight. These times are published in *AIP New Zealand* GEN 2.7 Daylight Tables, and are dependent on location and the time of year.

Discuss the following legal requirements for night flying: Aerodrome and aircraft lighting requirements, VFR night minimas for controlled (1500 feet/5 km) and uncontrolled (1500 feet/8 km), including the prerequisites below.

Prerequisites

Students must have completed at least two hours instrument flight time, which includes the following instrument flight manoeuvres, before they may undertake night flight training:

- Straight and level flight – maintain heading to a required accuracy of ±5 degrees, ±100 feet altitude and in balance.
- Medium and rate one turns – at least 180 degrees turns left and right, in balance, to within ±10 degrees of pre-selected roll out heading with a maximum altitude variation of ±100 feet.
- Climbing and descending – to preselected altitudes. Level flight to be re-established at the preselected altitude, no more than ±100 feet.
- Unusual attitude – prompt and correct recovery from unusual attitudes.

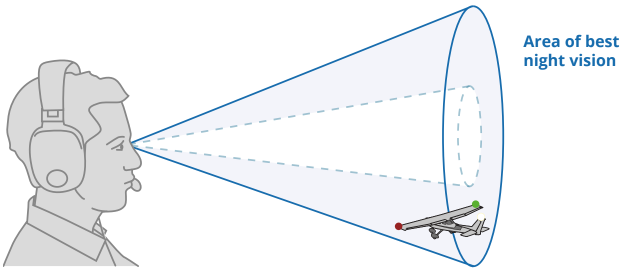
PPL night flying requirements: two hours dual, two hours solo, five hours total.

Night vision

Light-sensitive nerves, called cones and rods, are located at the back of the eye. The cones are located in the centre of the retina, and the rods are concentrated in a ring around the cones.

Figure 1

In low light, central vision doesn't work as well



Cones detect colour, details and faraway objects.

Rods are used when something is seen out of the corner of the eye, ie, for peripheral vision. They detect objects, particularly those that are moving, but do not give detail or colour. Rods make night vision possible. Because the rods are distributed in a band around the cones and do not lie directly behind the pupil, off-centre viewing (looking to one side of an object) is important during night flight.

In low light, central vision doesn't work as well, so peripheral vision is relied on. As peripheral vision is good at noticing changes, objects are more likely to be noticed at night with peripheral vision (see Figure 1).

Central vision is still required to read instruments or charts, but it's important to preserve as much function in peripheral vision as possible. In order to achieve this, allow time for the eyes to adapt to the dark, avoid bright light by keeping cockpit lights and torches as dim as possible, and use a practised scanning motion when looking outside the aeroplane.

Dark adaptation

Allow time to adjust to low light after completing any tasks that need to take place in bright light, such as the preflight inspection. The rods become fully effective after approximately 30 minutes, so avoid any bright light once dark adaption has started.

Be aware that mobile phones can have very bright displays.

Illusions

A careful lookout on the ground and in the air is critical. It's very easy to lose sight of other aircraft lights as they merge with background lights.

Speed perception is very difficult at night, and it's common to find the taxi speed building up without noticing it. Consciously taxi slower than normal.

Transfer to instruments quickly after take-off. The horizon will probably not be visible, so attitude, speed and direction must be maintained with reference to the aeroplane's instruments.

The student should already be familiar with the illusions they may experience when instrument flying. These will still be present at night.

In addition, the following illusions can be experienced at night:

- Flicker vertigo – flashing lights and flickering from propellers can cause disorientation.
- Auto-kinesis – a fixed light source against a dark background can appear to move. Avoid looking directly at the light.
- Ground light, starlight, or fishing boats, etc. In areas with little ground lighting, isolated lights can appear to be stars, making it seem the aeroplane is in an irregular attitude.
- Black hole – can happen when approaching a lit area over unlit terrain. That can cause the runway to seem out of position. Use the visual approach slope indicators, if available, or carefully monitor the flight instruments.

Equipment

For the preflight check, a torch will be required, in particular a torch powerful enough to be able to see the detail required. A headband torch can be useful.

While carrying out the preflight, note the position of the aeroplane on the aerodrome and the position of other aircraft.

It's also advisable to wear a high visibility jacket, and to be conscious of personal safety.

All lights should be checked to ensure they are working, including but not limited to: navigation lights, anti-collision lights, strobe lights, taxi lights, and landing lights. The pilot should also be familiar with the lights operation, how much can be seen with them and when they are used.

Internal aeroplane lighting, including the compass, must be operational and the pilot should know how to adjust the lighting levels.

The pilot's personal night equipment should include:

- Torch, with spare batteries
- Pen attached to the flight log, and a spare nearby
- Mobile phone
- Watch
- Warm clothing and a survival kit
- May like to carry a spare handheld VHF radio or GPS.

Familiarity with the aeroplane

It's important to know the location of the controls and switches, so the pilot can operate them without needing to look at them. At this stage of their training, the student should be familiar with the aeroplane.

Familiarity with the aerodrome

AIP Vol 4 aerodrome charts operational data details the lighting available on the aerodrome – a thorough knowledge of lighting facilities is important.

Discuss the location, colour, and if applicable, the direction of all aerodrome lighting, including: apron, taxi, holding point, runway, and approach lighting. If pilot activated lighting (PAL) is available discuss the operation of this.

Review ATC light signals.

Discuss the particular approach lighting available at the aerodrome, and how it's to be used, eg, PAPI. Check that the student can decode the lighting codes, and they know where to find the decodes for those they cannot.

Weather

Inadvertent IMC is more likely at night. Exercise extreme caution. It can be very difficult to recognise weather deterioration and extremely hard to determine if cloud is blocking the view of terrain.

At night there is less mixing in the air up to 2000 feet and the surface wind will lessen and back. This can also mean the surface wind is significantly different from the wind at circuit altitude.

When the night is overcast, it will be much harder to identify cloud than it would be on a clear night.

Pay particular attention to the temperature/dew point relationship as an indicator of potential fog and low cloud.

Emergencies

Detail the procedures to carry out in the event of the following emergencies:

- Radio failure – follow the local procedure, use the aeroplane's lights and squawk 7600.
- Runway lighting failure – the flight will need to divert to another aerodrome where lighting is operational. This will need to be checked during the planning stages.
- Landing light or navigation light failure – the flight can continue, but should end at the next landing.
- Internal light failure – the flight can continue, but should end at the next landing.
- Electrical failure – should be noticed before total failure because of the increased frequency of SADIE checks. Total failure is a serious event and the flight should land as soon as practicable. Use the standard overhead join procedure.
- Engine failure – is particularly difficult to deal with at night. If the surface can be seen in the moonlight, plan for a normal forced landing. If the ground cannot be seen, fly at the minimum descent speed (1.1 V_S) and turn into wind. Do not use flap unless the ground can be seen. Landing lights should only be used from below 400 feet AGL as the glare will reduce the ability to see beyond the light's beam.

See the *Night VFR* GAP booklet for further information.

Airmanship

Preflight in the light if possible, otherwise use a good torch.

Correct use of taxi/landing lights and strobe light.

Consider the number of other aircraft in the circuit, as it can be hard to see them at night.

Caution – illusions as discussed above.

Fly above the 'minimum elevation figure'. This can be determined from the MEF figures on the VNCs.

Identify local landmarks and lighting patterns – if any disappear, such as a neighbouring community – there is a strong likelihood of cloud or fog development.

Aeroplane management

More frequent SADIE checks.

Particular attention should be paid to dew on windscreens and frost on wings.

Cockpit layout familiarity.

Trust the instruments.

Human factors

Instrument flying illusions will be present.

Night vision factors – 10/30 minute adaptation, health (I'MSAFE), importance of oxygen to brain and eye function, colour perception, depth perception, focus (cones and rods), focal length (myopia), black hole, lights and stars.

Air exercise

On the ground

Taxi slowly.

Recognise runway lighting position in peripheral vision as this is the landing perspective.

When lining up, make sure to have a careful lookout for aircraft on the approach.

During take-off, use the runway lighting to keep on the centreline, because a reference point in the distance may not be available.

Once airborne immediately transfer to instruments to establish the aeroplane attitude and speed, and a positive rate of climb.

When established in the climb, a combination of instruments and visual reference can be used.

In the circuit

The first circuit should be a familiarisation circuit. It's a chance to see the local area, and compare how it looks at night to how it looks in the day. It's also a chance to orientate and locate local landmarks and townships.

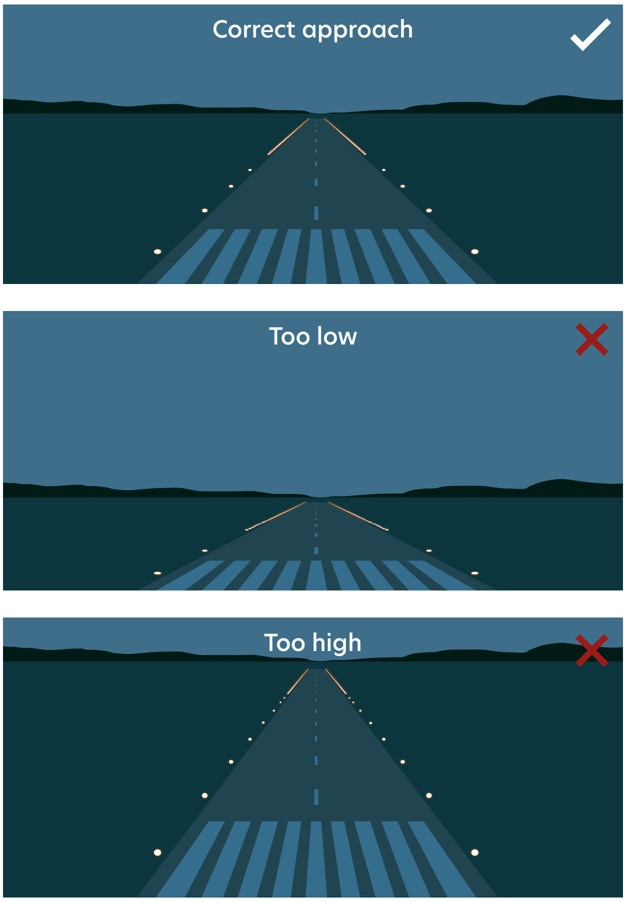
At night it can be difficult to see the runway lighting from the downwind position. Care must be taken positioning the aeroplane downwind at the correct spacing.

Approach and landing

At night the runway edge lights must be used to judge the approach perspective (see Figure 2).

Figure 2

At night, use the runway edge lights to judge the approach perspective



During the landing, it's important to use the runway perspective to judge the roundout and flare, not look for the ground in the landing light. The first few landings should be completed without the landing light.

Be careful of too much speed when turning off the runway.

Airborne sequence

Teach night taxi principles, and application factors such as: apron, runway, and light recognition.

Take off and vacate the circuit to familiarise the student with the different night perspective, including: black hole effect, lack of depth perception, other illusions, speed and direction of other aircraft, and above all, the importance of lookout.

Return to the circuit and carry out approach and low overshoots to view the runway lighting perspectives of too low, on profile, and too high.

Conduct night circuits, progressively introducing various emergencies.

Night flying

Objective

To operate the aircraft safely both on the ground and in the air at night within 25 NM of the aerodrome.

Considerations

- Night is between ECT and MCT
- Legal: Aerodrome /aircraft lighting and minima (controlled /uncontrolled)

Prerequisites

- 2 hours IF
- PPL – 2 hrs dual, 2 hrs solo, 5 total

Night vision

- Rods and cones
- Cones – colour
- Rods – peripheral vision and movement
- Used for night vision

Dark adaptation

- 30 minutes
- Avoid bright lights

Illusions

- Lookout
- Speed perception
- Lack of horizon
- IF illusions
- Flicker vertigo
- Auto-kinesis
- Star light confusion
- Black hole

Equipment

- Torch, and spare batteries
- High viz
- All lights operational
- Personal equipment – torch, pen, mobile phone, watch, warm clothing, survival kit, possibly spare VHF or GPS

Familiarity with aeroplane

- Know location of controls and switches

Familiarity with aerodrome

- Vol 4 operational data
- Aerodrome lighting
- ATC light signals
- Approach lighting

Weather

- Inadvertent IMC
- Diurnal wind effect
- Overcast vs clear sky
- Temp and dew point

Emergencies

- Radio failure
- Runway lighting failure
- Landing or nav light failure
- Internal light failure
- Electrical failure
- Engine failure

Air exercise

On the ground

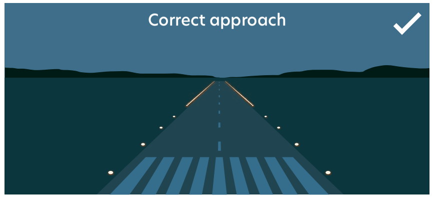
- Taxi slowly
- Notice runway light in peripheral vision
- Aircraft on approach
- Transfer to instruments as soon as airborne
- When established in climb, can use visual reference

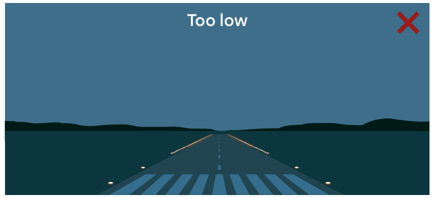
In the circuit

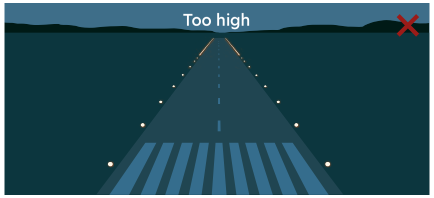
- Familiarity with the circuit
- Local landmarks and townships
- Downwind spacing

Approach and landing

- Approach perspective with runway edge lights
- Don't look in to the area lit by landing light
- Speed when vacating
- Emergencies – simulate
- Illusions – experience







Airmanship

- Preflight in the light
- Use of aeroplane's lights
- Number of other aircraft in the circuit
- Illusions
- Minimum elevation figures

Aeroplane management

- More frequent SADIE checks
- Dew and frost
- Cockpit layout
- Trust instruments

Human factors

- Instrument flying illusions
- Night vision factors – adaptation, health, oxygen, colour perception, depth perception, focus, focal length, black hole, lights and stars

Visual navigation

Navigation is much more than simple map-reading, and this navigation section of the Flight Instructor Guide refers to the guide Practical Flying Guide 1: Visual Navigation.

The techniques recommended in the guide are thoroughly explained and are not repeated here.

1

Dead-reckoning navigation

Introduction

Having learnt how to fly an aircraft, and cope with emergencies and abnormalities, the teaching of navigation brings the student to the point of using the aircraft to travel somewhere. It brings together much of what has already been learned into the context of a cross-country flight, where the student learns not only how to fly but also how to manage a flight. It is in this phase of training that a student's ability to build and maintain situational awareness, assess differing conditions and situations, and make good decisions needs to "step up" to a higher level. In this sense, it is much more than navigation training, and the instructor needs to make sure they emphasise these non-technical skills whilst teaching through this phase.

Visual navigation is a time-based activity, supported by map reading, and its success is dependent on good time management. There are many tasks for a pilot to remember and carry out, and good workload management is essential. A major emphasis the instructor must impart during navigation training is that of managing time and planning moments where specific tasks can be accomplished. A workflow or "routine" needs to be taught, based around a timescale.

Whilst technology in the cockpit brings many advantages and enhancements to flight safety it is imperative that the basics of visual navigation are thoroughly taught, using dead-reckoning techniques, supported by use of a paper chart. Instructors may find their students resistant to learning these basics when the technology is so good and will need to provide strong reasoning as to the importance of learning the basics first. There are two reasons for this;

- Firstly, the technology may fail. Tablets or phones may run out of power or overheat, causing them to shut down. Also, the GNSS signals that navigation software depends upon are very weak and easily interfered with. Space weather may occur with little warning and disrupt GNSS for minutes or even days. GNSS is susceptible to jamming and spoofing. In addition to GNSS interference, navigation displays may freeze, or navigation systems may suffer from electrical failures.

  PBN certified aircraft must have suitable back-ups in case of GNSS failure or disruption (inertial navigation, VOR/DME or visual navigation). VFR aircraft/pilots must use basic visual navigation techniques as the back-up.

- Secondly, but equally importantly is the development of time-based management skills, which will enhance workload management, increase capacity, and improve the non-technical skills. These skills transfer well beyond VFR flying, and make the transition to IFR and high-performance aircraft much simpler.

Navigation is much more than simple map-reading, and this navigation section to the FI Guide refers to the guide *Practical Flying Guide 1 – Visual Navigation*.

The techniques recommended in the guide are thoroughly explained and are not repeated here. To understand the intent of the lessons, the techniques to be taught, and the briefings in this section, it is essential the instructor is familiar with the guide.

Preparation

Prior learning

Before embarking on the navigation phase of training, there are some essential elements of learning which need to have been achieved. Whilst the student's skill in these areas may not be perfect, or complete, the basic principles and techniques need to have been well grasped.

Aircraft handling

Prior to the navigation phase the student must be able to climb the aircraft, whilst maintaining a heading to an altitude, level off and trim for straight and level flight. An ability to maintain the heading and altitude whilst 'in trim' will be essential, and without these basic skills, attempting to learn navigation will be frustrating or even counter-productive.

Map reading

The navigation phase, should not be the first time that a student has identified their position, or estimated a direction to head in, on an aeronautical chart or map. In fact, the basic skills of map reading should have been instilled through the early lessons.

The ability to use a chart should be introduced in small steps from the very first lesson. Initially pointing out key landmarks in the local area and relating them to their depiction on the chart. On subsequent lessons, teach the student to hold the chart "track up" as well as pointing out airspace boundaries. When teaching climbing and descending, introduce the vertical aspects of navigation by checking airspace altitudes and planning a climb or descent accordingly. In pre-flight briefings, always tell the student where the lesson will be conducted and point it out on the chart. Refer again to the chart during the debriefing, reviewing where the aircraft had been.

At the end of each lesson, where a join will be necessary, a discussion can take place between instructor and student as to their present position with direct reference to the chart. Key features to assist in finding the airfield can be identified and followed. Airspace can be identified and in the later lessons, a heading and distance can be estimated. Bear in mind that the student's estimates will be somewhat wayward to begin, but with the experience built up through practice, they will be building the skill and knowledge needed for navigating and cross-country flights.

Use of the radio

The use of the radio should be phased in over the early lessons, with limited exposure during the initial exercises building up to the student taking more responsibility as the training progresses. By the end of the circuit phase the student should be dealing with all the communications prior to leaving the circuit and after joining. Competency with the calls necessary for departing and joining the circuit, as well as changing frequencies should quickly follow thereafter. It is all too easy for the instructor to make the joining call on completion of each lesson, especially when the frequency is busy, and time is pressing to get back for the next lesson. In some circumstances this is the correct course of action, but whenever possible the student should be encouraged to make the R/T call(s).

During the post circuit training (such as Advanced Turning or Forced Landings) instructors should teach their students how to make an accurate position report. They should also teach how to contact FISCOM (or another suitable station) to obtain information such as an Area QNH, a NOTAM, or a METAR.

Aeronautical publications

Instructors should be gradually introducing the use and interpretation of the AIP, the Supplements and NOTAMs. It is important to keep this very simple to start with, to avoid over-whelming the student. But, like map reading, make small steps progressively building up knowledge.

Weather assessment

At an early stage take the time to teach how to assess the suitability of the weather from the available weather information. Teach the principle of assessing the 'big picture' of weather and asking the question such as is the weather expected to improve, remain stable or deteriorate? How will the weather be towards the end of the flight? Teach the comparison of a TAF with actual conditions experienced so and by 'looking out of the window'. Relate visibility to the distance of a nearby visible feature. Encourage the student to check the forecast weather before each lesson and, with some help, compare that with actual conditions particularly as it relates to a Go/No go decision.

In-flight teach the student to make reasonable assessments of cloud base, visibility and wind at typical cruising altitudes. Their initial attempts may not be very accurate, but will improve rapidly with experience, provided you remember to include it during the lesson.

Threat and Error Management

Threat and Error Management (TEM) techniques should be discussed from the outset of the training course, with the practical application of the techniques demonstrated and practised throughout the early lessons.

Ground course

Whilst the student pilot will have thoroughly studied navigation for the purpose of passing the theory examination, a comprehensive ground course will need to be delivered to apply those principles in a practical sense before airborne navigation training commences.

Syllabus

Appendix 1 provides a suggested syllabus for a typical ground course and is based on the techniques depicted in the guide *Practical Flying Guide 1 – Visual Navigation*. This list can be used or adapted as required to take account of the local environment. The content of the ground course would take at least a whole day to deliver but could be spread over several briefings.

Visual Navigation Guide

As previously stated, this navigation section of the Flight Instructor Guide assumes the use of the techniques described in the guide *Practical Flying Guide 1 – Visual Navigation*. As such it can be used as a reference text for students to understand and learn these techniques.

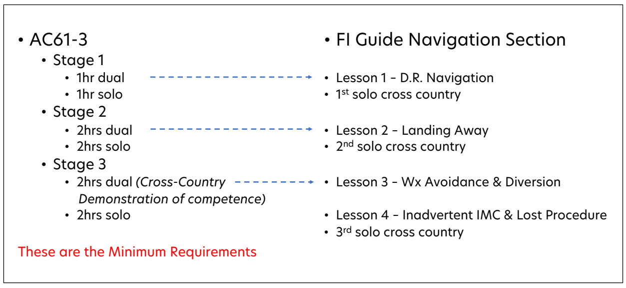
It is well worth encouraging students to thoroughly learn or even over-learn, the techniques and "rules of thumb" from the guide, on the ground. This would include WHAT checks, track error estimation, standard closing angle calculations, practising the free hand drawing of track lines, estimating the degrees in True, and converting to Magnetic.

Structure of navigation training

AC61-3

The material and guidance to instructors offered in this section should be used alongside the requirements stipulated in AC61-3, and the FTSG PPL Cross-Country Demonstration of Competency. The lessons complement the 'stages' described in the AC as shown in the table below.

Figure 1



- AC61-3
  - Stage 1
    - 1hr dual
    - 1hr solo
  - Stage 2
    - 2hrs dual
    - 2hrs solo
  - Stage 3
    - 2hrs dual *(Cross-Country Demonstration of competence)*
    - 2hrs solo

- FI Guide Navigation Section
  - Lesson 1 – D.R. Navigation
  - 1st solo cross country
  - Lesson 2 – Landing Away
  - 2nd solo cross country
  - Lesson 3 – Wx Avoidance & Diversion
  - Lesson 4 – Inadvertent IMC & Lost Procedure
  - 3rd solo cross country

These are the Minimum Requirements

Included in Lesson 4 is the recovery from an inadvertent entry into IMC. This is an additional and optional item to those listed in the AC and is recommended as a safety enhancement.

Lesson templates

The variables of aircraft type, student ability, local airspace considerations and weather patterns will ultimately dictate the construction of each flight lesson and the exact order of events.

Therefore Lessons 1 to 4 provided in this section are *templates* designed to be adjusted as appropriate to accommodate differences in operating environment. Ideally Lesson 1 should be a triangular route with 20-minute legs but can be adjusted if required. The remaining lessons should be adjusted to suit the training location. For instance, a relatively long flight may be required to reach a controlled aerodrome, or terrain may influence a route and individual legs. It may be more suitable to have 3 lessons, or even 5 lessons rather than 4. When making such adjustments it is important to ensure that the techniques are taught in a logical sequence and that enough time is available on each leg to prevent the student from becoming over-loaded. Equally, the whiteboard briefing must be adjusted to represent the actual route to be flown.

Routes to be planned by the student, should be determined by the instructor to ensure that they are suitable for teaching the techniques during a dual flight, and for safe practice and consolidation during solo flights.

Solo flights must be integrated with the dual flights in a similar manner to the Stages of the AC.

In-flight navigation equipment

Equipment used in the cockpit should be well managed and kept to a minimum. Using the techniques of the *Practical Flying Guide 1 – Visual Navigation*, the only equipment that needs to be 'to hand' is the chart, a pen or pencil, a time piece and a navigation log. All other equipment such as a circular slide rule, a protractor or navigation ruler are for planning on the ground and should be stowed.

Airborne lessons

1. Dead-reckoning navigation

This is the first flight in the navigation phase and lays the foundational methods and techniques which will be built upon in further lessons. The instructor needs to focus on three areas in this lesson; flight planning, DR navigation and workload management within defined time frames.

To ensure the integrity of the taught exercise, unlike other lessons, the instructor should not introduce deliberate errors. Instead fly accurately and allow errors, changes in the wind for example, to present themselves naturally. And then correct these using the appropriate techniques.

Objectives

1. Complete pre-flight planning
2. Conduct DR navigation
3. Utilise timing to manage workload

Considerations

[*For full details of the techniques used refer to:* Practical Flying Guide 1 – Visual Navigation.]

Before the day of the flight, the instructor should have given the student a simple triangular route to plan that will take approximately one hour, each leg covering approximately 20 minutes of flight time at normal cruising speed.

On the day of the flight ask the student to check and interpret the AIP, supplements and NOTAMs as applicable. They should also check and assess the suitability of the weather conditions. They can then complete their planning but will probably need help with this. Their navigation log and chart or map should be prepared as per the *Visual Navigation* guide and the instructor should check this and point out any corrections that may be needed. Even if the school has a flight following system installed in the aircraft, the student should still be taught how to file a VFR Flight Plan.

The final stage of the planning process is to review the route, identifying, or ideally refreshing from the chart what might be seen at each of the fixes and turning points so that there is an awareness of what to expect prior to getting airborne. This is the time to identify potential threats (e.g. lowering cloud, changes of wind, danger areas, likely traffic, circuit or instrument traffic at aerodromes) and human errors (e.g. misreading headings or times, airspace boundaries including altitude changes) and discuss error prevention and mitigation (checking danger area status, radio calls, gross error checks and WHAT checks).

Airmanship

Workload will be high when learning to navigate. The structured and time-based approach to navigating will help in distributing tasks and managing workload.

Self-discipline needs to be applied to achieve accurate flying, particularly in holding a heading. Guesswork must be resisted, and the heading only changed, when properly re-calculated.

Care must be taken to avoid becoming too absorbed in the navigating alone, but to ensure other important tasks are being attended to, such as lookout, radio calls and cruise checks.

Aircraft management

Regular cruise checks need to be integrated using time as a prompt into the overall workload management of the flight.

The alignment of the Direction Indicator (DI) must be checked frequently. The DI should also be checked after a Turning Point as a large change of heading can lead to the DI being out of alignment.

During a cross country flight, where the aircraft is in the cruise configuration for most of the time, it is appropriate to lean the mixture for performance and economy. Remaining fuel and endurance should also be noted in the Fuel Log section of the Navigation Log.

Human factors

Always maintain a thorough lookout. Avoid too much time “head down” by determining when to put away the map and concentrate on flying and looking outside of the aircraft. When looking at the map, hold it up so that peripheral vision outside, is maintained.

The student can suffer from a strong tendency toward confirmation bias, particularly when identifying a key feature to confirm their position, i.e.; “seeing what they want to see”. To prevent this, teach them not to accept the feature until it is properly identified using it’s “distinguishing features”.

The student may sometimes feel uncomfortable in not being certain of the aircraft position. Using the method of TIME – MAP – GROUND, should establish approximate position and dispel such discomfort.

Air exercise

The student should pre-flight the aircraft, start up, taxi and complete run ups and take-off checks.

Prior to take off, the initial stage of the flight should be reviewed or briefed, including circuit departure, visual references, speeds, airspace and altitudes. The student conducts the take-off and initial climb and then the instructor should take control and teach how to correctly identify the Start Point (SP), reading from map to ground. The instructor should position the aircraft over the SP at the planned altitude, speed and on heading, and ask the student to take note of the time overhead. Having established the aircraft straight and level, in trim and on track, teach the gross error check. Orientate the map to “track up” and compare features on the ground with the track drawn on the chart. Ideally use features straight ahead and in the distance. Then teach the WHAT check:

- **W** Weather; check ahead
- **H** Heading; as per the Navigation Log. DI alignment checked
- **A** Altitude; as per the Navigation Log, or adjusted for weather. Airspeed as per planned
- **T** Time; in the Navigation Log write down the time overhead the SP and ETA for the Turning Point (TP) or destination, and confirm the time for the next fix

Stow the map and hand over control to the student to fly straight and level. This is an important step as it demonstrates to the student that the map is not required all the time during navigation, and that there is no need to follow progress with a finger on the chart. Point out the time available till the first fix and suggest a task that fits within this time frame, such as a cruise check. Emphasise that during this period the student should have capacity, to lookout and maintain situational awareness, such as weather conditions or traffic in the area.

Not less than 2 minutes before the first fix, take control and teach how to fix the position of the aircraft. Emphasise TIME – MAP – GROUND and then using "large to small", "lead in" and "distinguishing" features identify the fix and establish the aircraft position. Mark this on the map and teach how to correct for any error in track and time. Begin by considering why the error exists. If it's due to the wind, then teach correcting for track error by calculating a new heading. Then apply Standard Closing Angle (SCA) to regain the track. In the same way teach for any error in time using the Proportional Technique. Write down the new heading or ETA in the Navigation Log, if these have been changed.

Teach the method for correcting heading or time on an opportunity basis. Do not artificially induce an error.

Point out the time available till the second fix, stow the map and hand over control to the student to fly straight and level, and suggest another task that fits within the time frame, such as an appropriate radio call. Make sure the student has had an opportunity to contact FISCOM. In this flight it could be as simple as obtaining the Area QNH or amending the SARTIME.

With 2 minutes to run to the second fix, take control and repeat the process of identifying the fix, establishing aircraft position and making corrections where necessary, noting this down on the Navigation Log. Then hand control back to the student, point out the time available to the turning point (TP) and suggest another task within the time frame.

With approximately 2 minutes to run to the TP, take control and teach the actions to identify the TP and execute the turn onto the next leg so that the aircraft is overhead the TP and on the next heading. The student can carry out a gross error check, followed by the WHAT check. Make it clear to the student that this is the same routine as was completed at the SP. Developing these workflows and routines are an essential part of the navigation training.

Essentially, during the first leg navigation tasks are completed by the instructor while flying, with the student only handling the controls during the straight and level portions of the cruise. A common instructor error is to leave the student in control whilst teaching the navigation elements. This will quickly lead to the student being over-whelmed and the instruction being in-effective. It is vital the student can give their full attention to the navigation instruction being given.

During the second leg the same workflows are used, with time being the prompt to instigate the next actions. The emphasis now changes with the student given practice in managing time and completing the navigation tasks (position fixing, calculating corrections to heading and ETA, and amending the Navigation Log), whilst the instructor flies the aircraft. Again, the exception is the portions of the leg when the map is stowed, during which the student should be in control. At the end of the second leg, the student should be able to carry out the procedures at the TP whilst retaining control of the aircraft.

For the final leg, the student will have been taught all the necessary workflows and routines to complete the leg from both a navigation and flying perspective, so should be tasked both to fly and navigate. However, the student may still require some assistance, particularly with any corrections at the fixes. Avoid multiple prompts, but instead try to give the student the opportunity to practise, only intervening if it seems the purpose of the leg will be lost. As this is the final leg of the flight, during portions when the map is stowed, you might suggest the student reviews and briefs the arrival and join, if their capacity allows.

Having navigated on the third leg, the aircraft should be close enough to the aerodrome to allow the student to organise the join, enter the circuit and land. To prove the accuracy of the student's estimate for the field, it may be useful, if appropriate, to join overhead. This would then provide an ideal opportunity to practice a Standard Overhead Join.

Dead-reckoning navigation

Objectives

- Complete pre-flight planning
- Conduct DR navigation
- Utilise timing to manage workload

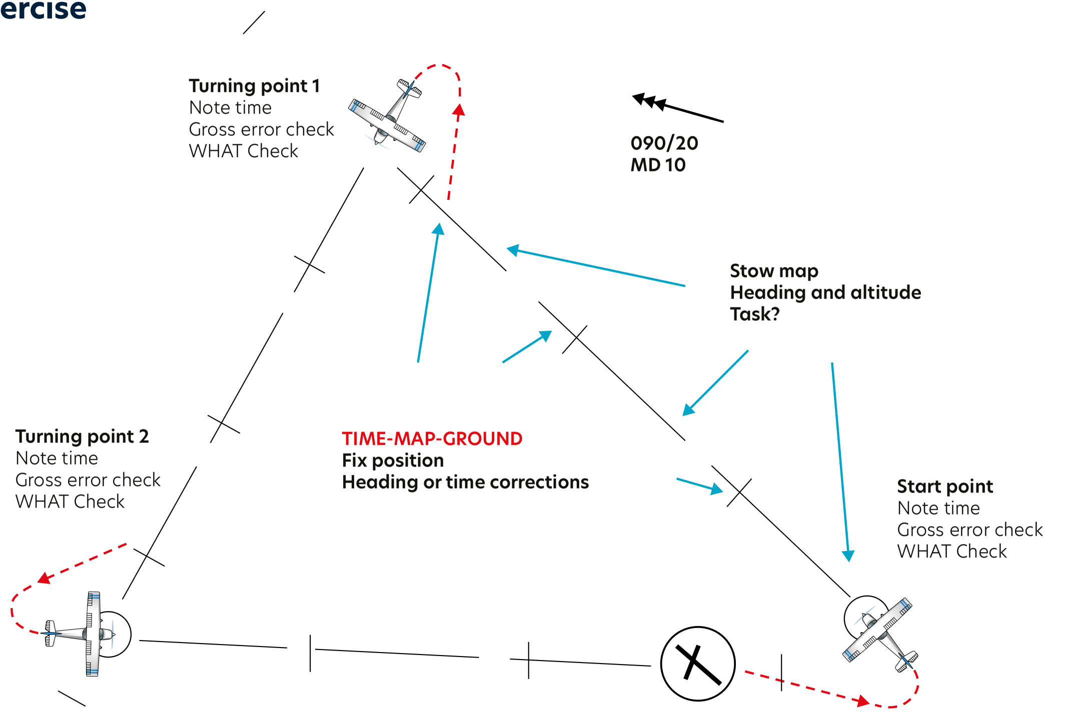
Considerations

- Assess weather forecast and actual conditions
- Check NOTAM, AIP and supplements
- Complete pre-flight planning & map preparation
- File a VFR Flight Plan (if required)
- Review the route, identify threats

Flight conduct

- **Leg 1:** Instructor flies while teaching navigation. Student flies when map stowed.
- **Leg 2:** Instructor flies while student navigates. Student flies when map stowed.
- **Leg 3:** Student flies and navigates. Practice SOHJ

Air exercise



Turning point 1
Note time
Gross error check
WHAT Check

090/20
MD 10

Stow map
Heading and altitude
Task?

TIME-MAP-GROUND
Fix position
Heading or time corrections

Turning point 2
Note time
Gross error check
WHAT Check

Start point
Note time
Gross error check
WHAT Check

Airmanship

- **LOOKOUT**, workload – time-based structure

Aeroplane management

- Cruise checks, DI alignment, fuel log, leaning

Human factors

- Planning tasks, confirmation bias, disorientation; **TIME-MAP-GROUND**

2
Landing away

Objectives

1. To land at a controlled aerodrome
2. To navigate at low level
3. To land at an unattended aerodrome

Considerations

[*For full details of the techniques used refer to:* Practical Flying Guide 1 – Visual Navigation.]

Like the previous lesson, the instructor will have given the student a route to plan in advance, with a controlled aerodrome at the end of the first leg and an unattended aerodrome at the end of the second leg.

The student should carry out all the normal planning with some assistance from the instructor. Ensure that the landing and take-off performance at the land away airfields are considered using the AFM.

During the briefing, check the student's planning, including their assessment of the weather and NOTAMs. Brief the R/T procedures required when transiting or entering controlled airspace, as well as those for arriving at a controlled airfield. Referring to the AIP discuss the published procedures and relevant information for the airfield. Review the layout, signage, taxiways, holding points, refuelling points and the likely routing to a suitable parking area after landing.

In the same way review R/T and procedures published in the AIP for joining at an unattended aerodrome.

Discuss the use of the "Minimum VFR Altitude to Continue" as a decision-making tool before there is a need to fly at low-level. However, if a rapid and unexpected change of the weather takes place, flight at low level may be required. Discuss the effect of operating at low-level on the ability to see features on the map, particularly the inability to see lateral features (towns, lakes, wooded areas, etc), whereas vertical features such as masts, aerials and some elements of terrain become more obvious. Aspects of wind effect and illusions learnt in the Low Flying exercises, will be applied where relevant.

Discuss the checks recommended before descent and the configuration to be used, and revise Rule 91.311 Minimum heights for VFR flights.

Airmanship

The student should adopt a structured and time-based approach to navigating, distributing tasks and managing workload.

Self-discipline needs to be applied in holding a heading, and only changing the heading when properly re-calculated.

Care must be taken to avoid becoming too absorbed in the navigating alone, but to ensure other important tasks are being attended to, such as lookout, radio calls, planning an arrival or standard overhead join, and cruise checks.

Aircraft management

As taught in the last lesson, aircraft management is integrated into the workflow and should include regular cruise checks, leaning of the mixture, as well as fuel monitoring and recording.

Human factors

Workload management, using time frames, resulting in a thorough lookout and situational awareness being maintained. Use of TIME-MAP-GROUND to counter any disorientation, and descent checks for low level.

Air exercise

The first part of the lesson should be a revision of the previous lesson, starting prior to take-off where the student briefs the aerodrome departure and heading to the SP. After take-off they should climb to the SP and set course on the first leg. Throughout the flight the student's task is to fly the aircraft and navigate using the previously taught techniques. During the periods where the map is stowed, the student should be including collection of the ATIS (if applicable) and, with assistance, briefing the arrival. Approaching the controlled airspace, which can be identified using TIME-MAP-GROUND, the instructor should take responsibility for the R/T in order to demonstrate the correct calls and read-back of the clearance. Some guidance may be required to enable the student to orientate themselves as the destination airfield is approached. It is sometimes better to take control and demonstrate a join at the airfield if it appears to be becoming difficult for the student, rather than make a hurried join with the instructor delivering instructions for the student to follow. Once established in the circuit, control can be passed back to the student to complete the circuit and landing. On the ground vacate the runway and, if possible, stop to review the airfield layout on the AIP plate. The instructor should take control whilst taxiing and negotiating any runway crossing, pointing out relevant signage and R/T procedures. The student can follow along by looking at the plate. Navigating on the ground at an un-familiar airfield can be quite challenging and presents many threats. It is important to teach this well as part of this phase of training.

The student can carry out all the necessary actions and procedures to get airborne again, and set off on track at normal operating altitude, on the second leg of the planned route. Once established, simulate an un-forecast and rapid lowering cloud base ahead by nominating a maximum operating altitude and allow the student to practise descending to and operating at low level. Additionally, poor visibility could be simulated, and the student could then revise the adoption of the poor visibility configuration. If this configuration is used, a correction to the estimated time for the leg should be calculated, as well as amending the fuel plan.

Once established at the lower cruise altitude, take control and teach the changes in features that are now visible, as well as the need to anticipate ground features coming into view. Highlight the value of being able to follow a suitable line feature to achieve the next turning point, if one is available. When following a line feature, revise the need to keep the feature on the left. If it is not be possible to fly in a straight-line track, teach how maintain an awareness of the overall heading being flown and time being taken, to prevent disorientation.

Approaching the unattended airfield, the low-level part of the exercise is complete, and the aircraft can be climbed back up to the normal operating altitude, from which point the joining procedure can be practised. If the student's workload is getting too high at this point, take control to allow them to catch up and be fully prepared. Once the student has caught up again, hand over control.

Once the student has landed the aircraft, the student should follow the procedures for vacating the runway, giving way to other aircraft, crossing runways, observing signage and making the radio calls as applicable.

On the third leg, the student can practice their low-level navigation returning to the home airfield.

Landing away

Objectives

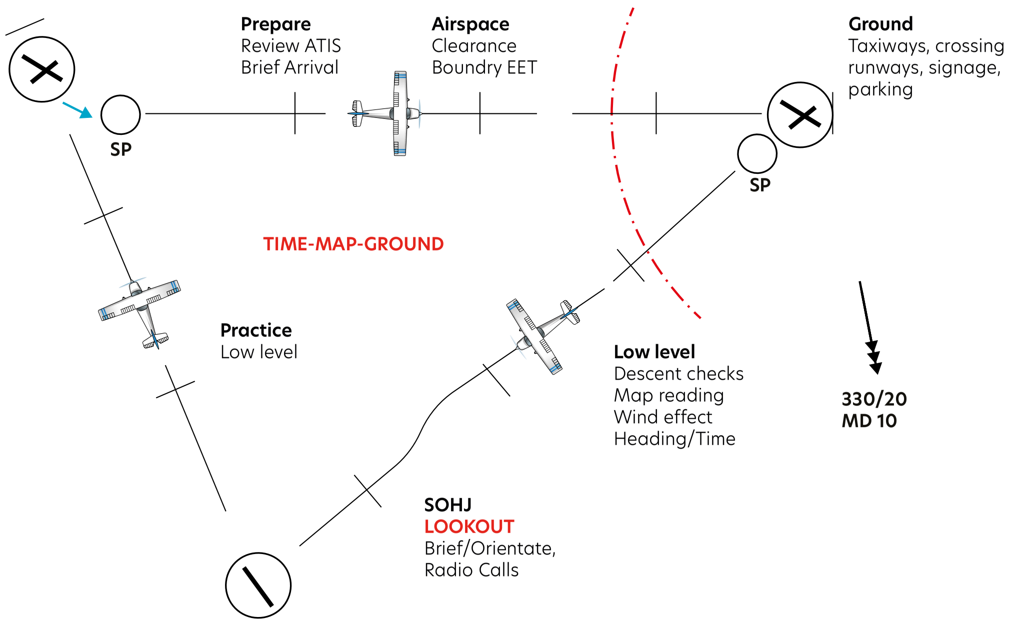
- To land at a controlled aerodrome
- To navigate at low level
- To land at an unattended aerodrome

Considerations

- **Assess Wx and NOTAM, check planning and map**
- **Controlled airspace:** R/T and arrival
- **On the ground:**
  - Airfield layout, signage, parking
- **Low level nav:**
  - Minimum VFR altitude to continue
  - Map reading / effect of wind
- **Unattended aerodrome:**
  - Arrival / SOHJ / ground movements

Air exercise

Note: Diagram should represent actual planned flight



Airmanship

- **LOOKOUT**, Arrival, SOHJ – plan ahead

Aeroplane management

- Cruise checks, DI alignment, fuel log, leaning

Human factors

- Workload; plan using time frames, disorientation; **TIME-MAP-GROUND**

3

Weather avoidance and diversion

Objectives

1. To conduct the weather avoidance procedure
2. To plan and execute a diversion
3. To practice low level navigation

Considerations

[*For full details of the techniques used refer to:* Practical Flying Guide 1 – Visual Navigation.]

Like previous lessons, the instructor will have given the student a route to plan. The student should plan three legs, each approximately 20 minutes flight time. However, the third leg should not go back to the home airfield, but to another waypoint. The third leg will be used to plan and execute an en-route diversion back to the home airfield.

On the day of the flight the student should have completed planning for the route and carried out all the pre-flight actions, including NOTAMs and weather assessment. Again, some instructor input and advice may well be needed. Make sure the student has marked the wind on the map including the maximum drift.

A thorough briefing will be required before this flight lesson is conducted, particularly the techniques to be used for weather avoidance and the en-route diversion, as well as the threats or errors which could require one.

Airmanship

A structured and time-based approach to navigating, distributing tasks and managing workload to ensure other important tasks are being attended to, such as lookout, radio calls, cruise checks and weather assessment.

Aircraft management

Regular cruise checks, leaning of the mixture, as well as fuel monitoring and recording.

Human factors

Workload management, using time frames, resulting in a thorough lookout and situational awareness being maintained.

Air exercise

Starting prior to take-off the student briefs the aerodrome departure and heading to the SP. After take-off they should climb to the SP and set course on the first leg. The student should be capable of navigating to the first Turning Point (TP) with the minimum of instructor input using the techniques taught in the previous lessons.

On arriving at the first TP, the student should be able to identify the TP and set course along the next leg.

Once the aircraft is successfully established on the second leg, take control and teach the weather avoidance technique which uses a dogleg to leave track, avoid the weather, parallel track if appropriate, and then return to track. If possible, try to regain track before the next fix, so that the success of the dogleg technique is confirmed. After the fix, allow the student to practise the weather avoidance method, returning to track before the next TP.

If an actual weather avoidance is not necessary, rather than just simulating a rain shower try to organise the route where there may be some isolated high ground. Then simulate a low cloud base. This will result in a dogleg around the high ground and being able to literally see how it works. This does depend on the local terrain and thinking ahead when the route for planning is initially given to the student.

Once past the second TP, take control and teach how to plan and perform a diversion to an alternative destination. Start by nominating the diversion destination (in this case the home airfield) and then a suitable SP, either a ground feature or a point along the time scale (e.g. in 3 minutes time). Then teach them to free hand a line on the chart from the SP to the destination, and then to estimate the True track, convert to Magnetic and calculate a heading derived from the maximum drift already marked on the map. Position to be overhead the SP and on the new heading. Note the time and emphasise the gross error check and the WHAT check, as the chance of making a mistake in airborne planning is increased. The student should then draw in 6-minute markers and estimate ETA. They can then choose suitable fixes noting the time to the next fix. Once this is complete, the map can be put away, hand control back to the student and from this point onwards the techniques to navigate this leg are no different to any other leg previously flown. Once under way, other tasks can be accomplished in the same managed way as previously taught, and would include a review of any airspace ahead, fuel remaining, fuel required and MSA for the leg.

The student should be able to manage the arrival and entry to the circuit. Consider practicing a different type of approach and landing, such as a flapless, short-field or glide approach.

Weather avoidance and diversion

Objectives

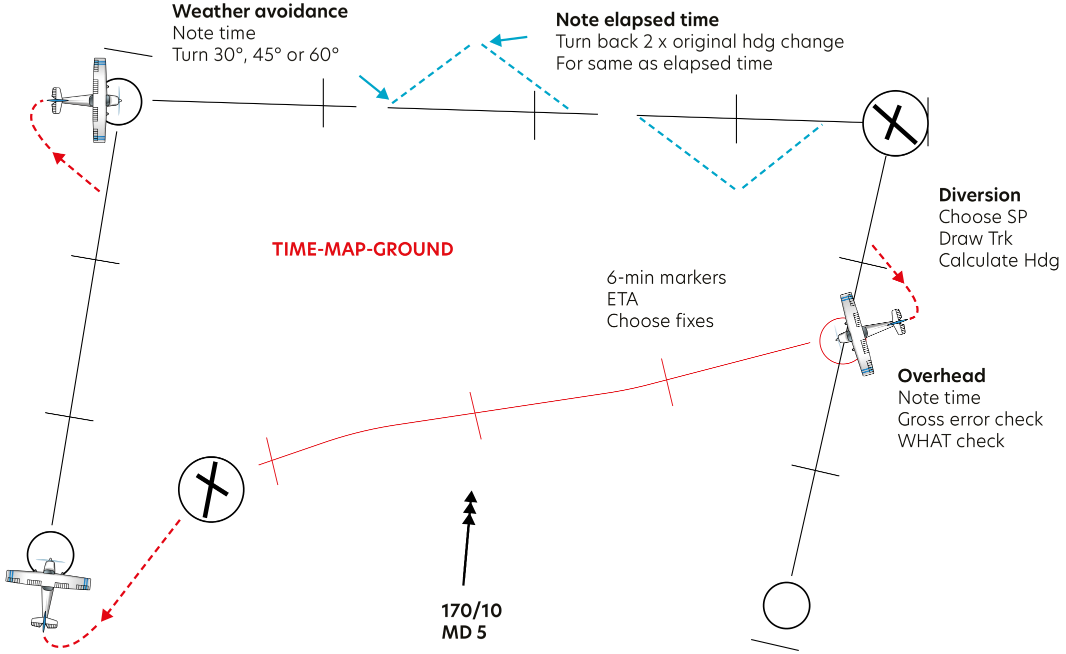
- Conduct weather avoidance procedure
- Plan and execute a diversion
- Practice low level navigation

Considerations

- **Assess Wx and NOTAM, check planning and map**
- **Weather Avoid**
  - 30°, 45° or 60° turn
  - Timing and ETA adjustment
  - Turn back or parallel track
- **Diversion**
  - Select SP, draw Trk T° – M° – Hdg
  - 6-Min Markers, ETA

Air exercise

Note: Diagram should represent actual planned flight



Weather avoidance
Note time
Turn 30°, 45° or 60°

Note elapsed time
Turn back 2 x original hdg change
For same as elapsed time

TIME-MAP-GROUND

6-min markers
ETA
Choose fixes

Diversion
Choose SP
Draw Trk
Calculate Hdg

Overhead
Note time
Gross error check
WHAT check

170/10
MD 5

Airmanship

- **LOOKOUT**, time-based structure – weather assessment

Aeroplane management

- Cruise checks, DI alignment, fuel log, leaning

Human factors

- Planning tasks, confirmation bias, disorientation; **TIME-MAP-GROUND**

4

Inadvertent IMC and lost procedure

Objectives

1. To recover from an inadvertent entry into IMC
2. To carry out the lost procedure

Considerations

[*For full details of the techniques used refer to:* Practical Flying Guide 1 – Visual Navigation.]

This lesson will require some careful consideration and planning by the instructor to ensure the sequence of lesson objectives flows smoothly and does not become overly complex.

Impress upon the student that an inadvertent entry into IMC is a genuine emergency, and that the procedures you will teach need to be well learnt, so that they can be recalled when under stress. Discuss the actions to take to avoid flying inadvertently into IMC, and the actions to take if this happens, emphasising that the main priorities are to decisively establish an instrument scan, keeping the aircraft safe whilst planning a return to VMC.

Brief the procedures for when uncertain of position using TIME-MAP-GROUND, and the procedures when lost. Emphasise the importance of keeping track of heading and time, and not 'wandering around'. Explain the initial actions focus on getting some help, and that the secondary actions follow when help is not available, and a plan of action is needed to locate the aircraft's position.

Airmanship

Lookout. Assessment of weather.

Aircraft management

Regular cruise checks, alignment of DI, and descent checks for low level.

Human factors

Decision making to avoid inadvertent IMC using “Minimum VFR Altitude to Continue”, and “Minimum Safe Altitude” calculated during planning.

Air exercise

The student can carry out all the necessary actions and procedures to get airborne and set off on track at normal operating altitude on the first leg of the planned route.

At a suitable point take control and ask the student to put on a ‘hood’ and simulate a deterioration in weather and an inadvertent entry into IMC. Demonstrate the first action of maintaining control by decisively transferring from visual references to the instruments, building a scan whilst straight and level, and ensuring the aircraft is in trim. Then review MSA and either climb to MSA if the aircraft is below this altitude or descend to MSA if above. In most cases a return to VMC can be achieved by a 180° turn. Whilst this may not always be the case, there is a risk of making the scenario too complex, and the desired learning may not take place. Therefore, keep the exit strategy simple and teach the 180° turn. This should be planned with a target heading. Point out that once the turn is complete, some time may pass flying straight and level before exiting IMC. Also discuss actions in case this does not work. Maintaining the instrument scan, squawking 7700 and transmitting a “Distress” call to ATC without delay. During the debrief, discuss other potential scenarios of the recovery from IMC as discussed in the Visual Navigation guide.

Once you have completed the demonstration, place the aircraft in a suitable position and altitude, and give the student control so that they can practice these procedures.

Once the student has completed the recovery from IMC, take control and ask them to remove the ‘hood’. Point out and fly overhead a feature on the ground, taking up a new heading, and noting the time. Then ask the student to put the ‘hood’ back on, hand control back to them and instruct them to maintain straight and level flight, on the new heading. Ask them to carry out a cruise check, and to update the fuel plan, or other similar tasks. This will be good instrument flying practice but will also keep them slightly distracted from the aircraft position. Whilst maintaining the heading, take control, and whilst the student is under the ‘hood’ ask them to locate the aircraft’s position on the map. Ideally, they will use TIME-MAP-GROUND, and based on the heading flown and time elapsed since flying overhead the feature, they will be able to approximate position on the chart.

Hand control back to the student, and whilst maintaining the heading, ask them to descend to low level. After a few minutes, take back control, ask the student to remove the ‘hood’ and teach the ‘lost’ procedure.

The instructor needs to emphasise the priorities if the student becomes lost. Safety of the aeroplane is of prime importance. Noting down the time, remaining in VMC, maintaining an effective lookout and carrying out a cruise check (particularly DI to compass check and fuel endurance remaining) should be the first actions. Point out the risk of “wandering” off the heading, and that the heading should be maintained. Then make a call to the most appropriate ATC unit, most likely FISCOM, declaring being lost and requesting assistance. If this is unsuccessful, maintain the heading until a visual feature is seen. Then hold overhead that feature, noting down the time, and trying to identify it using GROUND – MAP.

Ask the student to check the actual heading flown since the last confirmed fix, and the time taken from that fix to the current position. From the last fix, they can plot the track flown, and add 6-Minute Markers to establish a DR fix and construct a “circle of uncertainty”, radius 10% of the distance flown since the last reliable fix. They should select a line feature on the map outside the circle of uncertainty. Hand control back to the student and they can set heading towards the line feature, map reading using GROUND – MAP. On reaching the line feature, they should fly along it until another feature is found and the aircraft position is established.

The result of this teaching should give a fix on the chart, from which the student can practise calculating an in-flight diversion to return the aircraft to the home airfield.

Inadvertent IMC and lost procedure

Objectives

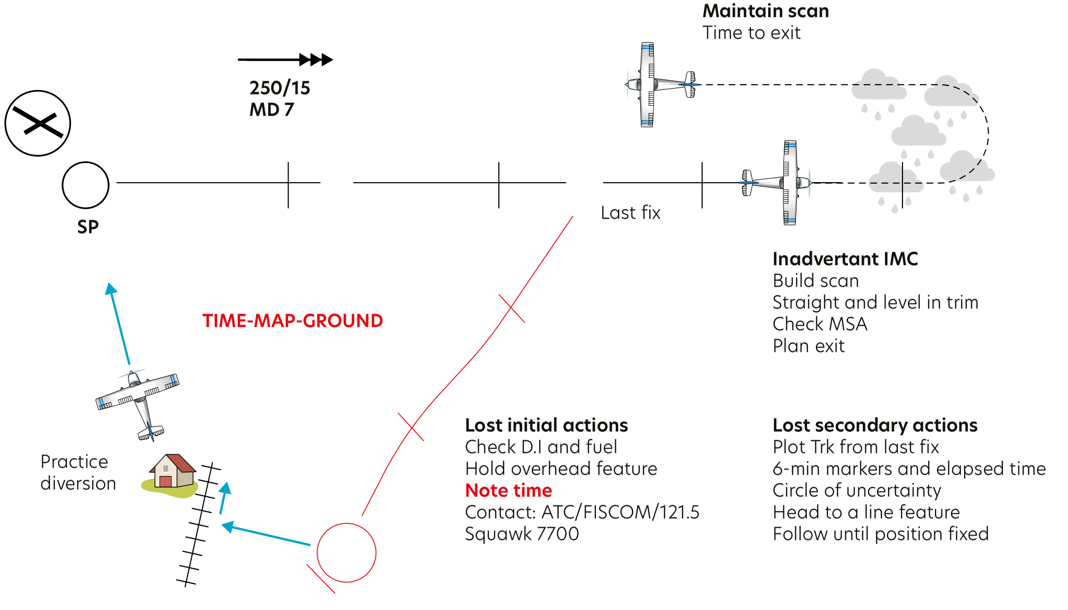
- Recover from an inadvertent entry into IMC
- To carry out the lost procedure

Considerations

- **Assess Wx and NOTAM, check planning and map**
- **Inadvertent IMC:**
  - Prevention/transition to I/F and MSA
  - Exit plan/"Distress" call and 7700
- **Practice I/F**
- **Uncertain of position:** **TIME-MAP-GROUND**
- **Lost:** Initial actions/secondary actions
- **Practice diversion:** Back to home airfield

Air exercise

Note: Diagram should represent actual planned flight



Maintain scan
Time to exit

Inadvertant IMC
Build scan
Straight and level in trim
Check MSA
Plan exit

Lost initial actions
Check D.I and fuel
Hold overhead feature
Note time
Contact: ATC/FISCOM/121.5
Squawk 7700

Lost secondary actions
Plot Trk from last fix
6-min markers and elapsed time
Circle of uncertainty
Head to a line feature
Follow until position fixed

Airmanship

- **LOOKOUT**, workload – time-based structure

Aeroplane management

- Cruise checks, DI alignment, fuel log, leaning

Human factors

- Workload; plan using time frames, disorientation; **TIME-MAP-GROUND**

Supervision of solo cross-country

Solo flights will be integrated into this phase of training and will depend on the order and content of dual flights as well as the capabilities of the individual student.

It is recommended that all solo routes be carefully chosen by the instructor to minimise problems such as airspace, lack of ground features or high ground, unless these problems are intended to give the student specific practice.

Students should only ever be sent on a solo cross-country flight where their competence matches the requirements of the planned route, their planning has been carefully checked, they are thoroughly briefed, the weather is suitable with healthy margins and the flight is properly supervised.

The first solo landing away from the home airfield should not be to any aerodrome at which the student has not previously landed dual, and should not present problems such as short runways, unfamiliar air traffic services or crosswinds.

As part of the supervision a "Sign-out Checklist" is recommended to ensure all aspects of the flight have been checked and briefed by the supervising instructor. An example can be found at Appendix 2 and can be used or adapted to local requirements.

Students should be encouraged to carry a phone, money or credit cards, a coat (even in summer) and a small overnight bag. This will make the decision to divert or turn back to an airfield other than the home airfield, or possible overnight much easier.

Whenever the student takes the decision to divert or wait out the weather on the ground, this must always be met with positive reinforcement from the instructor, even if the weather seemed suitable.

During the solo flight, the supervising instructor should monitor weather and conditions such as issues at the airfield. If equipped, the student's progress can also be monitored with aircraft tracking devices.

At completion of the solo flight, a debrief should always take place and the student's map and Navigation Log checked. A great deal of learning and confidence building will take place on these solo cross-country flights, and the debriefing is essential to ensure good practice is reinforced and errors or problems are thoroughly discussed.

Appendices

Appendix 1
Ground course

Maps

- Map selection
- Interpretation, legends
- Preparation; tracks, fixes, 6-minute markers, fan-lines

Flight planning

- Weather forecast, reports and interpretation
- Choice of route
- Controlled airspace
- Danger, prohibited and restricted areas
- Navigation Log

Calculations

- Magnetic heading(s) and time(s) en-route
- Safety altitudes
- Fuel planning
- Mass and balance
- Performance

Flight information

- AIP, Supplement and NOTAMs
- Radio frequencies
- Selection of alternate aerodromes

Aeroplane documentation

Notification of the flight

- Pre-flight administrative procedures
- Flight plan, SARTIME, closure
- Supervision of solo cross-country
- Sign-out procedures

Organisation of cockpit

- Navigation equipment
- Watch/stopwatch
- Phone, money, coat, overnight bag

Departure

- Published departure procedures
- Controlled aerodromes
- Unattended aerodromes
- Start point procedures
- Gross error check, WHAT check

En-route

- Altimeter settings, Area QNH
- ATC liaison in controlled airspace
- R/T procedures outside controlled airspace
- Maintenance of heading, altitude and speed
- Time management; 6-minute markers, ETAs, time between fixes
- Use of map, identifying features
- Track error and heading corrections
- Time corrections
- Regaining track, Standard Closing Angle
- Navigation Log maintenance
- Fuel monitoring and recording
- Turning point procedures
- Use of radio, flight information service
- Minimum weather conditions for continuation of flight
- In-flight decision making
- Transiting controlled airspace, MBZs
- Danger and restricted areas, other hazards
- Weather avoidance procedures
- Diversion procedures
- Uncertainty of position procedure
- Lost procedure
- Inadvertent entry into IMC

Arrival and aerodrome joining procedure

- Published arrival procedures
- Controlled aerodromes
- Unattended aerodromes
- Altimeter setting
- Standard overhead join
- Entering the circuit
- Circuit procedures
- Ground movement, signage, crossing runways
- Parking
- Securing the aircraft
- Refuelling
- Closing of flight plan, if appropriate
- Post-flight administrative procedures, occurrence reporting

Appendix 2
Sign-out checklist

The Solo cross-country sign-out checklist is provided on the CAA website in an editable Word document, to be adapted as required to the local environment and circumstances.

Solo Cross-Country – Sign Out Checklist

Note: Prior to the flight, this form must be completed and signed by the student and the instructor and left at the base airfield along with a copy of the navigation log, prepared chart and fuel plan.

Planned route:

From: ____________________ To: ____________________

To: ____________________

To: ____________________

For an ETD of: ____________________ hrs NZST/NZDT on date: ____________________

The navigation plan has been checked and the following items discussed and, where applicable, the required information noted on the plan.

Weather:

Forecast checked as suitable for route for entire period of flight (minimum by day 2000ft agl ceiling and 16km vis; minimum by night 3000ft agl ceiling and 16km vis). ☐

Lowest altitudes to continue VFR specified, and diversion options discussed. ☐

NOTAMs / AIP Supplement:

Checked for effect on flight. Discussed any action required. ☐

Aircraft:

Serviceability and documents ☐

Sufficient fuel and oil including reserves ☐

Mass and balance ☐

Performance for all airfields ☐

Pilot:

Medical valid ☐

IMSAFE discussed ☐

Dual instruction last 5hrs and piloting last 30 days checked ☐

Valid exams checked ☐

Phone, money, coat, overnight bag ☐

Route:

Need and method of maintaining VFR ☐

Specific hazards en-route ☐

Altimeter zones ☐

Controlled airspace, MBZ's, military areas and danger areas briefed ☐

Destination: AIP plate available and briefed, special procedures, SOHJ, circuit direction, fuel availability, choice of runways, and other points as applicable ☐

Alternate aerodrome; suitability and procedures discussed ☐

R/T procedures:

Frequencies noted on plan ☐

Use of FISCOM ☐

SARTIME ☐

Airfield joining ☐

Lost procedure ☐

PAN/MAYDAY ☐

Abnormal and Emergency Procedures:

Action in event of intrusion into controlled airspace ☐

Action in event of weather deterioration and/or fuel shortage ☐

Action on becoming lost ☐

Action in event of an unscheduled landing ☐

Notes:

(Instructor must be A/B-Cat) I certify that the student has been briefed and that their planning has been checked i.a.w. this form, and that I will supervise the flight i.a.w. Rule 61.105

Instructor name:

Licence No:

Instructor Cat:

Instructor's signature:

Date:

I certify that I have been briefed for the navigation exercise detailed above and understand that in the event of an unscheduled landing I will contact the CFI or his/her deputy by the quickest possible means and act according to their instructions.

Student's name:

Date/Time:

Student's signature:

On completion of flight

Copy of completed navigation log, map and fuel plan attached to this form and returned to instructor for document storage.

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New Zealand Government

See the CAA website for civil aviation rules, advisory circulars, airworthiness directives, forms, and more safety publications.

View the FIG online at aviation.govt.nz/fig

aviation.govt.nz

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